

MODEL LANDSCAPE IRRIGATION EFFICIENCY ORDINANCE
PROPOSED DESIGN GUIDELINES

Irrigation Standards Committee

**Arizona Department of Water Resources
Tucson Active Management Area**

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Adapted from the California State Model Water Efficient Landscape Ordinance to meet the needs of the Tucson Metropolitan Area

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I. PURPOSE

The “Model Irrigation Efficiency Ordinance” and “Design Guidelines Manual” are the result of over a year of bimonthly meetings between representatives of several departments from the Arizona Department of Water Resources, City of Tucson, Town of Oro Valley, Town of Marana and Pima County. In addition, representatives from Tucson Unified School District (TUSD), local landscape companies, irrigation specialists, landscape architects, and irrigation suppliers and distributors have been participating and providing expertise.

One of the major benefits of the Irrigation Efficiency Ordinance is its ability to provide regional uniformity of standards and reduce confusion for developers and landscape professionals working in multiple jurisdictions. At the same time, it does not encumber small projects with the extra expense of irrigation meters, irrigation audits and other requirements of the ordinance.

Historically irrigation efficiency has not been addressed in landscape design and management practices. Due to ever-increasing demands on our limited water resources and inefficient uses of water there is a need for regional irrigation efficiency standards and implementation guidelines. This manual is intended to clarify the requirements of the Irrigation Efficiency Ordinance (*Reference the ordinance by its legal title and section of the code. Identify whom to contact for the latest adopted version*) for the regulated parties designing, installing and maintaining landscapes and irrigation systems to comply with the ordinance and for the staff reviewing and enforcing the ordinance.

These guidelines provide design flexibility by allowing elements that are high water use such as water features and turf, while requiring overall irrigation efficiency by establishing mandatory yet equitable irrigation allotments, water budgets and irrigation sub-metering on commercial sites that have landscapable areas of ½ acre or more. Since the ordinance targets fewer “large” irrigators overall, and places the primary responsibility for compliance on a licensed or certified professional, it is easier to administer and reduces its impact on staff that would otherwise be inspecting landscape and irrigation system installations.

The specific goals of this model ordinance are:

- (A) To encourage consistent irrigation and landscape standards across jurisdictions in the Tucson area.
- (B) To reduce the use of groundwater for irrigation, reduce overall per capita water use and encourage use of renewable water resources such as reclaimed and Central Arizona Project (C.A.P.) water for irrigation in the Tucson metropolitan area.
- (C) To encourage the use of harvested rainwater on public and private landscapes to reduce the use of potable water for landscape irrigation.
- (D) To reduce irrigation-related water-waste in commercial, industrial and publicly owned landscapes.

- (E) To reduce irrigation water usage without sacrificing landscape quality by establishing better irrigation systems, maintenance practices and watering schedules, and through the use of low water use plants, improved planting design and appropriate planting practices.
- (F) To reduce water waste from over-watering, inefficient watering, or release of excess water which generates fugitive water in the public right-of-way. To reduce damage to publicly owned streets and the public expenditures necessary to repair the damage caused by wasted water.
- (G) To apply equally stringent requirements at publicly owned government facilities to lead by example.

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II. DEFINITIONS

For the purpose of this article, the following definitions will apply unless the context clearly indicates or requires a different meaning. This list includes both the legal definitions within the regulation and definitions of other related terms used in the Design Guideline Manual.

ACRE – A measure of area. One acre of land contains 43,560 square feet

ACRE FOOT – A measure of volume. One acre foot of water is one acre covered with water to a depth of one foot and is equivalent to 325,851 gallons or, 43,560 cubic feet of water

ACTIVE MANAGEMENT AREA (AMA) – An active management area is a geographical area that has been designated by the Legislature (pursuant to Title 45, Chapter 2, Article 2) as requiring active management of groundwater. The Tucson AMA is one of five active management areas in the state.

AREA – Square footage or acreage measured and calculated from scale plans, photographs, or from on-site measurements.

ATHLETIC FIELD- A turf area used primarily for organized sports.

AUTOMATIC CONTROLLER - A solid state timer capable of operating valve stations to set the days, time of day, and length of time water is applied.

BODIES OF WATER- Include fountains, swimming pools, spas, water sculptures, canals, channels, waterfalls, constructed ponds and lakes, or other elements using water as part of a design.

BUBBLERS - Flood irrigation heads that deliver water to the soil adjacent to the heads.

BUFFERYARD – The on-site use of landscaping elements, screening devices, open space drainageways, and landforms for reduction of the potentially adverse impacts of adjoining, incompatible land uses.

C.A.P. WATER - Central Arizona Project water.

CEMETERY- An area of land being used for cemetery related purposes, including any area of land covered by grave markers and landscaping, and excluding: buildings; walks; pathways; roads; parking lots; and any area of land being held for future expansion of the cemetery.

CHANGE OF OWNERSHIP - When the legal deed to a property and its structures is transferred to a new owner through a sale, exchange, gift or inheritance of said property.

CITY OWNED - Property owned by **XXX**.

COMMON AREA - A recreational or open space area or areas, owned and operated as a single integrated facility and maintained for the benefit of the residents of a housing development.

COMMERCIAL FACILITY- Any commercial or industrial use facility with a landscapable area of ½ acre or more, including offices and retail centers.

COMMERCIAL USE - The buying, selling, leasing, or storage of real or personal property or the furnishing of services for compensation. The term shall also include manufacturing, warehousing, the parking or storage of equipment, machinery, or supplies to be utilized elsewhere for compensation.

CONSTRUCTION USE - Use of water for construction purposes, including the use of water for dust control, compaction, and preparation of building materials on construction sites.

CUBIC FOOT – Volume equivalent to 7.48 gallons.

DEVELOPMENT- Any permitted or non permitted human alteration to land and its vegetation, soil, geology, drainage, hydrology and surface features, that changes the appearance and character of land. Including, but not limited to, the acts of grubbing, clearing and grading of land, and placing improvements on the land, such as buildings, structures, signs, paving, vegetation, and outdoor use areas.

DISTRIBUTION UNIFORMITY (D.U.)- An accepted industry standard method used to rate how evenly water is applied to an irrigated area. The more evenly the water is applied, the higher the rating. distribution uniformity is directly related to irrigation system performance.

DISTURBED SLOPES - Slopes that have been altered, from their natural configuration or vegetative cover, by human activity.

DRIP IRRIGATION - A low pressure, low volume irrigation system of pipe and emitters that applies water slowly, near or at ground level to minimize runoff and loss to evaporation.

DRIP LINE- For cacti: an area around the plant that overlays the mature root system. For trees and shrubs: the outer edge of the undisturbed canopy of the tree or shrub.

EFFICIENCY STANDARD – A value or criterion that establishes a volume of irrigation water use in the ornamental landscape.

EMISSION UNIFORMITY - Applied to drip and micro irrigation, is a comparison of the total output flow from the lowest rate 25% of the emitters on the system compared to the total average emitter flow of the system.

EMITTER- An irrigation system component that dispenses water to plants at a predictable rate, measured in gallons per hour, used with drip irrigation, bubblers and micro-spray systems.

EVAPOTRANSPIRATION- The quantity of water evaporated from soil surfaces and transpired by plants.

EXPANSION OR MAJOR RENOVATION- Any expansion or major renovation to a commercial or industrial use facility that increases its landscapable area to ½ acre or more. Or,

any major renovation to building(s) or landscape area(s) that reduces the total square footage of landscapable or landscaped area that was calculated and submitted on the previously approved landscape plan.

EXTERIOR WATER USE - Non-residential or residential uses of water for landscaping, pools, evaporative cooling systems, misting systems, decorative fountains, and other outdoor uses of water.

FIXED SPRAY IRRIGATION - The application of water to landscaping by means of a fixed spray device that projects water through the air, in the form of small particles or droplets over an area, typically $\leq 20'$ radius.

FLOW RESTRICTION DEVICE - Device applied by the water utility to the customer's meter that restricts the volume of flow to the customer.

FLOW SENSOR - A device used to measure flow and provide the information to a controller.

FUGITIVE WATER – Water pumped, flowing, released, escaped, or leaked onto adjacent property or the public right-of-way from any pipe, valve, faucet, connection, diversion, well, or any facility for the purposes of water supply, transport, storage, disposal, or delivery.

GOLF COURSE - A turf related facility used for playing golf with a minimum of nine holes and including any practice areas.

HARVESTED RAINWATER - Precipitation runoff collected, directed or stored that is available for use on landscaping to sustain the plantings or supplement irrigation.

HYDROZONES – A portion of a landscape area having plants with similar water needs and in the same microclimate that are either not irrigated or irrigated by a circuit or circuits with the same schedule.

HYDROZONING- A design practice of grouping plants by similar water requirements, exposure (e.g. microclimates); slope; and soil infiltration rates to maximize potential efficiency of irrigation.

INFILTRATION RATE - The amount of water absorbed by the soil per unit of time, usually expressed in inches per hour.

INSPECTION - An entry into, and examination of premises, for the purpose of ascertaining the existence or nonexistence of violations of this article.

IRRIGATION CONTROLLER - A mechanical or electronic clock that can be programmed to operate remote-control valves.

IRRIGATION EFFICIENCY- Refers to the relationship between the horticultural needs of the plants being irrigated and the amount of water actually applied.

LANDSCAPABLE AREA - The entire parcel including privately owned medians, less the building footprint, driveways, non irrigated portions of parking lots and required off-street parking.

LOW WATER USE PLANTS - Plants that are able to survive with minimal or no supplemental water once established as specified in the “Arizona Department of Water Resources (ADWR) Low Water Use/Drought Tolerant Plant List” published by the state and updated annually for the Tucson Active Management Area.

MASTER PLANNED COMMUNITY- A development that is either: 1) subject to a master declaration of covenants, conditions or restrictions; 2) subject to restrictive covenants sufficiently uniform in character to clearly indicate a general scheme for improvement or development of real property, or 3) is governed or administered by a master owners association.

MAYOR - The Mayor of ~~XXXXXX~~ or his/her designated representative.

MASTER VALVE - A device that can isolate or turn off a main line automatically.

MICROCLIMATE - The climate of a small area resulting from the modification of the general climate by local differences in elevation or exposure.

MINI OASIS ALLOWANCE - A certain percentage of the land area on a site where plants not listed on the ADWR Drought Tolerant Plant List may be used, and that is located where the oasis will return maximum benefit in terms of cooling, aesthetic pleasure and exposure to people.

MULCH - Any material such as leaves, bark, straw, decomposed granite, or other materials applied to the soil surface to reduce evaporation.

MULTIFAMILY HOUSING UNIT - A mobile home in a mobile home park and any permanent housing unit having one or more common walls with another housing unit located in a multifamily residential structure such as a unit in a duplex, triplex, fourplex, condominium development, town home development, or apartment complex.

NATIVE VEGETATION - Plants indigenous to the Sonoran Desert.

NEW DEVELOPMENT - 1) Any development except single family residential, approved by the ~~XXXXXX~~ Planning Department on or after ~~XXXXXX~~. 2) Development approved by the Department prior to ~~XXX~~, but not completed by ~~XXXX~~ shall also be considered new development. 3) For development for which landscaping is required by code, only that portion of a development approved by ~~XXXX~~ Planning Department on or after (~~XXX~~ date) shall be considered new development.

OVERSEEDDED AREA - An area of land planted with any cool-season grass species that grows over a dormant warm-season grass species during the fall-winter period. No extra water allotment will be given for overseeding.

PARKS - Public or privately owned recreation areas such as open space, recreation facilities and trails, publicly owned undeveloped natural lands, and non-commercial picnic areas and campgrounds.

PRECIPITATION RATE - The amount of water applied by an irrigation system per unit of time over a given area, usually expressed in inches per hour.

PUBLICLY OWNED - All property that is owned by a city, county, state or federal government, or “Special District” established by election or government action.

PUBLIC RIGHT-OF-WAY - The area of land acquired or obtained by the city, county, or state primarily for the use of the public for the movement of people, goods, vehicles, or storm water. For the purposes of this article the public right-of-way shall include the landscapable area between the street edge or curb and the adjacent property line.

RECREATIONAL AREA- Any land area that is designated for recreation or contains facilities such as community recreational centers, pedestrian ways, swimming pools, picnic facilities, basketball and other sport courts, playground equipment and exercise equipment.

RESPONSIBLE PARTY - The owner of the property, facility, or operation during the period of time the violation(s) is observed.

ROTARY SPRINKLER HEAD - A device that projects streams of water in the form of small particles or droplets, through the air through rotation.

RUNOFF - Water that is not absorbed by the soil or landscape to which it is applied. Runoff occurs when water is applied too quickly (application rate exceeds infiltration rate), particularly if there is a severe slope. In this context, “runoff” does not include storm water runoff that is created by natural precipitation.

SPORTS FACILITY - One or more turf areas dedicated to playing a sport or sports (e.g. golf driving range, athletic fields for soccer, baseball, football etc.). For the purpose of this ordinance the facility would be privately owned and located on a commercial property, within a residential common area, or at a private school.

SPRINKLER IRRIGATION- Overhead delivery of water using bubblers, fixed spray heads and rotors. Precipitation rates will vary depending on system layout and type of head used.

SUBMETERING – Separate metering of a portion of water use associated with a metered water-service connection.

STATIC WATER PRESSURE - The pipeline or municipal water supply pressure as measured at the point of connection (P.O.C.) to an end user or meter in a no-flow condition.

TEMPORARY IRRIGATION SYSTEMS - Irrigation systems that are installed and permanently disabled once plants are established (maximum period of 36 contiguous months). These systems should only be used to establish areas of re-vegetation of native or drought tolerant plants that could survive in a healthy state on available rainfall.

TURF - A surface layer of earth containing regularly mowed grass. Turf grasses are considered high water use plants and include, but are not limited to, varieties of Bermuda and Bermuda hybrids, Ryegrass and Buffalo grass.

TURF RELATED FACILITY - Any facility with a high water use landscape [water-intensive landscaped] area of 10 or more acres, including cemeteries, golf courses, parks, schools or common areas within housing developments.

UNDISTURBED NATURAL AREA- An area of land maintained in its original condition with natural desert cover, native topography, and native vegetation intact.

VALVE - A device used to control the flow of water in an irrigation system.

WATER ALLOTMENT- A calculated maximum amount of irrigation water per site per year, based on the total square footage of “landscapable” area for new development or existing landscaped area(s) for existing development. In conjunction with predetermined water application rates for low water use plants and mini oasis plants and evaporation rates for bodies of water.

WATER AUDIT - The on-site survey and measurement of irrigation efficiency and the generation of recommendations to improve management efficiency.

WATER BUDGET - An amount of water application to an irrigated landscape, based on the estimated water use of individual plants at maturity, calculated in order to stay within the site water allotment.

WATER PROVIDERS - Cities, towns, private water companies, and irrigation districts that deliver water for non-agricultural irrigation uses such as residential, commercial, governmental, industrial and construction uses. Water providers can also include well cooperatives, mobile home parks, and improvement districts.

III. APPLICABILITY

Refer to pertinent section of the ordinance then clarify legalese. The ordinance applies to commercial, industrial and publicly owned facilities, common areas in multi-family and master planned communities, parks, cemeteries, athletic fields and private sports facilities having a minimum of ½ acre of landscapable area.

1. Except as provided in number **3 below**, this section will apply to:
 - a. All new development and expansions or major renovations to commercial, industrial and publicly owned facilities, common areas in multi-family and master planned communities, parks, cemeteries, athletic fields and private sports facilities having a minimum of ½ acre of landscapable area.
 - b. Commercial or industrial facilities upon change of ownership having a minimum of ½ acre of landscape area. Property changing ownership that is not expanding or renovating the landscape is not limited to the maximum mini-oasis percentage required for new development.
2. Projects subject to this section must conform to the provisions in **(insert ordinance ref. # here)**.
3. This section does not apply to:
 - a. Homeowner provided landscaping at single-family residences; or
 - b. Any project with a total landscapable area of less than ½ acre (21,780 square feet).

IV. LANDSCAPE DOCUMENTATION PACKAGE

GENERAL REQUIREMENTS

Reference pertinent section of the regulation then clarify legalese

Step One: A copy of the landscape documentation package and the Irrigation Efficiency and Design Submittal Checklist as described below conforming to (this chapter *reference code*) must be submitted to the (*city, town or county*). No permit will be issued until the jurisdiction reviews and approves the landscape documentation package. Any development plan requiring a permit, excluding individual single family residential properties, must calculate and submit their site water allotment and estimated landscape water budget. A copy of the approved landscape documentation package must be provided to the property owner or site manager along with the record drawings and any other information normally forwarded to the property owner or site manager. *Each jurisdiction may want to explain the specifics of their process in a separate section, what is due to whom in what format when and where with fax numbers, addresses etc.*

Each landscape documentation package must include the following elements, which are described in **Section V of this document** :

- 1) Irrigation Efficiency and Design Submittal Checklist
- 2) Calculation of the Maximum Annual Irrigation Allotment
- 3) Calculation of the Estimated Irrigation Budget for the Site
- 4) Landscape Design Plan
- 5) Irrigation Design Plan
- 6) Irrigation Schedules
 - (a) Establishment period
 - (b) Mature landscape
- 7) Maintenance Schedule
- 8) Grading Design Plan
- 9) Soil Analysis
- 10) Reclaimed Water Use Statement

Step Two: Once the installation has been completed the project manager must submit the Certificate of Substantial Completion Checklist and required documentation to the (*the designated department/division within each jurisdiction e.g. planning department*) for approval.

- 1) Certificate of Substantial Completion Checklist shall be submitted after installation of the project landscaping and irrigation system, including:
 - (a) Irrigation system audit results
 - (b) Verification of compliance with audit standards for irrigation efficiency

V. ELEMENTS OF LANDSCAPE DOCUMENTATION PACKAGE

This section explains in further detail what needs to be submitted for a new project, major expansion or renovation, or change of ownership as pursuant to (*insert reference for irrigation ordinance*) for projects meeting the applicability standards as previously explained in Section III, Applicability.

A. Sample Irrigation Efficiency and Design Submittal Checklist

Each landscape documentation package must include a cover sheet similar to the following example. It serves as a checklist to verify that the elements of the landscape documentation package have been completed. It also has a brief description of the project.

SAMPLE- IRRIGATION EFFICIENCY AND DESIGN SUBMITTAL CHECKLIST

Project Site: _____ Project Number: _____

Project Location (address and major cross streets): _____

Landscape Architect/ Irrigation Designer/ Contractor: _____

Included in this project submittal package are:
(Check to indicate completion)

- ___ 1. Calculated total annual water allotment for low water use plants in acre feet, gallons, or cubic feet
- ___ 2. Calculated total annual water allotment for mini-oasis plants in acre feet, gallons, or cubic feet
 - a) Calculated surface area of bodies of water (see definition), if applicable
- ___ 3. Annual Irrigation Allotment for the Site in acre feet, gallons, or cubic feet
(add the water allotments calculated in 1. and 2. above for low and mini oasis planting areas together to determine the total irrigation allotment for the site)
- ___ 4. Estimated Irrigation Site Budget (for mature landscape)
- ___ 5. Landscape Design Plan
- ___ 6. Irrigation Design Plan
- ___ 7. Irrigation Schedules
- ___ 8. Maintenance Schedule

Briefly describe any additional planning and design actions that are intended to achieve conservation and efficiency in water use:

Date: _____ Prepared By: _____

B. Maximum Annual Irrigation Allotment

Allotments, in conjunction with an appropriate irrigation system and plant selection, are the basis for achieving a water efficient landscape design. The maximum irrigation allotment establishes a limit on how much water may be applied per year to an irrigated landscape at maturity. However, it does not specify design and management criteria. To determine the irrigation allotment for the site, the following maximum annual irrigation application rates must be used:

1.5 acre feet per acre, for low water use landscaping;

4.6 acre feet per acre, for turf or other high water use landscaping, and;

5.8 acre feet per acre for bodies of water (which include fountains, swimming pools, spas, water sculptures, canals, channels, waterfalls, constructed ponds and lakes, or other elements using water as part of a design).

These application rates are based on average consumptive use and evaporation rates for plants (evapotranspiration rates, Eto) and pan evaporation rates for bodies of water for the Tucson area.

For new facilities, maximum annual irrigation allotments are assigned prior to installation of the landscaping. The allotment is calculated using the total percentage of allowable mini oasis pursuant to the "Irrigation Efficiency Ordinance" and low water use landscape areas shown on the landscape plan. These areas are multiplied by the above-described application rates to determine the allotment.

In the case of change of ownership, annual allotments shall be calculated by the new owner based on the existing landscaped areas, separated into mini-oasis and low water use areas, using the irrigation application rates above. The new owner shall submit the calculated allotment to the planning department for approval.

For cemeteries and parks the total square footage of allowable turf and/or high water use planting areas will be at the discretion of the (planning director?). Turf areas may be allowed if the area(s) will receive frequent use and there is no other suitable plant substitute or cost effective way to provide for the intended use. Use of turf or high water use landscaping for purely aesthetic reasons is discouraged.

A project's Annual Irrigation Allotment must be calculated using the following formulas:

New Construction - Calculating the Annual Irrigation Allotment:

The annual irrigation allotment for each site is based on the total amount of area available for landscaping (landscapable area).

Step One: Calculate the total landscapable area for the site in acres or square feet.

$$1 \text{ acre} = 43,560 \text{ square feet.}$$

Note: if the total landscapable area is $\frac{1}{2}$ acre (21,780 square feet) or more proceed to Step Two.

Step Two: Calculate the allowable portion of the total landscape (in acres or square feet) that can be planted in “mini oasis” plants under current regulations. (10 % of the landscapable area for multi-family, 5% for most other uses). *Parks and Cemeteries are calculated differently, see exceptions below.* Multiply the landscapable area calculated above by the maximum irrigation application rate (4.6 acre feet per acre per year, or 34.4 gallons per square foot) to determine the annual water allotment for the mini oasis area.

Example - Commercial Property: Using a landscapable area of 1 acre (43,560 sq. ft) x 5% = 2178 sq. feet maximum mini oasis area

$.05 \times 4.6$ (acre foot per acre) = .23 acre feet per year (irrigation allotment for the mini oasis area) or, $2,178$ sq. feet x 34.4 = $74,923.2$ gallons *Note: gallons to acre feet conversions are not exact due to mathematical rounding off.*

Step Three: If the site has a body or bodies of water (See definition) calculate the surface area of the water feature(s) in square feet. Multiply the total square footage for all water features times 43.4 gallons per sq. ft. (5.8 acre feet per acre per year for bodies of water). This is the amount of water that will evaporate from a body of water each year in Tucson.

The total water use for the body of water is not in addition to the mini oasis irrigation allotment but is deducted from the total mini oasis allotment for the site. The remaining water allotment is the maximum that can be used for irrigation of the mini oasis plantings.

Example: 100 sq. foot water feature x 43.4 = 4,340 gallons

If you look at the previous mini-oasis example the total irrigation allotment for that site is 74,923 gallons. Deduct the annual water feature use of 4,340 from the mini oasis allotment to determine how much water is available for the remainder of the mini oasis area of the site.

Example: $74,923 - 4,340 = 70,583$ gallons

Therefore, 70,583 gallons are available for irrigation of the mini oasis area per year, allowing sufficient water for the mini oasis portion of the landscape at maturity and more than enough to establish and maintain the landscape in the early years if managed properly.

The remaining landscapable area (the total landscapable area minus the mini oasis area.) will be considered the low water use portion of the site. The site gets a “mini oasis allotment” regardless of whether a mini oasis area will be installed on the site or not. The mini oasis allotment can be used to irrigate additional low water use vegetation, provided the total annual site allotment is not exceeded.

Step Four: Calculate the total low water use area in acres or square feet and multiply that number by the maximum irrigation application rate (1.5 acre feet per acre, or 11.22 gallons per sq. ft.) to determine the annual water allotment for the low water use areas.

100% of the total landscapable area minus the allowable 5% mini-oasis for commercial properties = 95% of the landscapable area for low water use planting.

Example - Commercial Property: Using a total landscapable area of 1 acre x .95 percent (41,382 sq.ft.) multiplied by 1.5 (acre foot per acre) = 1.43 acre feet per year irrigation allotment for the low water use planting area, or: $41,382 \times 11.22$ gallons = 464,306 gallons

Step Five: Add the irrigation allotments for mini oasis area and low water use area together. This determines the “Annual Irrigation Allotment” for the site. The landscape must be designed to stay within the total annual irrigation allotment when the landscape is mature.

Total Annual Irrigation Allotment:

Example: $.23 + 1.43 = 1.66$ acre feet per year, or:
 $74,923 + 464,306 = 539,229$ gallons per year

Step Six: To determine if the site is likely to stay within the annual irrigation allotment when the landscape is mature, count the plants on the planting plan by species and calculate the water use for each plant at maturity. (See Appendix C- ADWR Low Water Use Drought Tolerant Plant List for Irrigation Efficiency.) The plant list not only provides the mature canopy sizes for the plants on the list, it also has the estimated water use for each plant at maturity. Using the plant water use information from the list, total the number of gallons required by the low water use plants on the site. A separate calculation for the mini oasis plants must be done. It may be helpful to use the water use factor for mini oasis plants in the “Sample Spreadsheet for Estimating Site Irrigation Water Use at Maturity, page ___ for guidance for the mini oasis plants. Canopy sizes and water use at maturity have not been determined for individual oasis plants since there is no required list for these plants. Designers must estimate the mature canopy sizes for the oasis plants on the plan.

Add the water use for the low water use and mini oasis plants together. Compare the total irrigation budget for the site with the site irrigation allotment calculated in Step Five. If the amount of water required annually by the plants at maturity exceeds the irrigation allotment for the site, the designer must modify the plant selection (species or quantity) to stay within the allotment.

Exceptions: If the site is a cemetery, or a park and includes “approved” high water use landscaping, turf area(s) and/or athletic field(s), the annual allotment will be calculated based on the total square footage of high water use landscaping, multiplied by 4.6 acre foot per acre. Plus the total square footage of low water use landscaping multiplied by 1.5 acre foot per acre. The mature landscape must stay within the annual allotment. Future expansions or reductions in landscapable area will require submittal of the recalculated annual allotment to the (*presiding jurisdiction or department*) by the property owner or their authorized representative. Upon completion of the renovation the revised annual allotment will be enforced.

Major Expansions or Renovations - Calculating the Annual Irrigation Allotment:

Major expansions or renovations to facilities that result in a landscapable area of ½ acre or more, must use low water use plants from the approved low water use/drought tolerant plant list on 100% of the expanded or renovated landscape area. If the percentage of “existing” mini oasis areas on the site, is less than the mini oasis allowance available under current landscape code(s) for new facilities, the jurisdiction may allow the property owner to add additional mini oasis area(s). However, in no case shall the total percentage of mini oasis area on the site exceed the percent of allowable mini oasis pursuant to the “Irrigation Efficiency Ordinance.”

Step One: Calculate the total square footage of landscaped areas on the site including the proposed expansions or renovations, if less than ½ acre (21,780) the property is not subject to the provisions of the Irrigation Efficiency Ordinance (*reference here*). If greater than ½ acre proceed to Step Two to calculate the annual irrigation allotment. Mini oasis areas and low water use areas must be calculated separately. The maximum irrigation application rates apply.

Step Two: Calculate the portion of the total landscape in acres or square feet that are currently planted in “mini-oasis” plants or turf. Retention/detention basins planted with turf or other high water use plants are considered part of the mini oasis allowance. Multiply that number by the maximum irrigation application rate (*4.6 acre feet per acre per year, or 34.4 gallons per square foot*) to determine the annual irrigation allotment for the mini-oasis area.

Example - Commercial renovation: *the site to be renovated has 2 acres of existing landscaping and will be adding an additional ½ acre of landscaping during the renovation. 25% (½ acre or 21,780 sq. feet) of the existing landscaping is planted in mini oasis plants. Therefore, no additional mini oasis is allowed on this site since it already exceeds the 5% allowable under current regulation.*

$21,780 \times 34.4 = 749,232$ gallons available to irrigate the mini oasis annually

Step Three: Calculate the portion of the total landscape in acres or square feet that are currently planted in low water use plants. Multiply that number by the maximum irrigation application rate (*1.5 acre feet per acre, or 11.22 gallons per sq. ft.*) to determine the annual irrigation allotment for the low water use areas.

Example- Commercial renovation: *1½ acres of the existing landscape is planted in low water use plants, an additional ½ acre will be landscaped during the renovation. Since the site already exceeds the 5% allowable mini oasis under current regulation, the new landscaped areas (½ acre) resulting from the renovation must be planted in low water use plants from the ADWR plant list. Therefore the calculation is based on 2 acres of low water use planting areas.*

$87,120 \text{ sq. feet (2 acres)} \times 11.22 \text{ gallons} = 977,486 \text{ gallons}$

Step Four: Add the irrigation water allotments for mini oasis area and low water use area together. This determines the “Total Annual Irrigation Allotment” for the site. The total irrigation water applied to the landscape must stay within the annual site allotment when the landscape is mature.

Example: $749,232 + 977,486 = 1,726,718$ gallons (5.3 acre feet) is the annual allotment for the renovated site.

Step Five: Target Conservation Budget – Calculate what the irrigation allotment would be for the site, if it were being built today under current regulations.

Using the total landscapable area calculations from Step One above determine the total square footage that would be allowable “mini-oasis” area under current regulations for new development. Multiply that number by the maximum irrigation application rate (4.6 acre feet per acre per year, or 34.4 gallons per square foot) to determine the annual irrigation allotment for the mini-oasis area.

Example: total landscape area $\times .05\%$ = mini oasis allowance

Using the example above $87,120$ sq. feet (2 acres) $\times .05 = 4,356$ sq. feet

New Development mini oasis in sq. feet $\times 34.4$ = gallons

Example: $4,356$ sq. feet $\times 34.4 = 149,846$ gallons for the mini oasis

- 1) The remaining landscapable area on the site is considered the low water use landscape area. Multiply the total acreage of low water use landscaping times the maximum irrigation application rate (1.5 acre feet per acre, or 11.2 gallons per sq. ft.) to determine the annual irrigation allotment for the low water use portion of the site.

Example: $87,120$ sq. feet (2 acres) $\times .95$ (low water use plant portion) = $82,764$

New Development low water use in sq. feet $\times 11.2$ = gallons

Example: $82,764 \times 11.2 = 926,956$ gallons

- 2) Add the irrigation allotments for mini-oasis area and low water use area together. This determines your “Target Conservation Water Budget” for irrigating the site.

Example: $149,846 + 926,956 = 1,076,802$ gallons is the Conservation Target for the site

Compare the “Total Annual Site Water Allotment” to the “Target Conservation Water Budget” for the site.

*Example: $1,726,718$ gallons is the current allotment for the existing landscape
 $1,076,802$ gallons is the conservation target*

Target reduction in irrigation water use on the site = $649,916$ gallons

The conservation water budget should be used as a voluntary target in an effort to reduce overall water use on the site over time.

Change of Ownership - Calculating the Annual Irrigation Allotment:

Step One: Calculate the total square footage of existing landscaped areas on the site, if less than ½ acre (21,780) the property is not subject to the provisions of the Irrigation Efficiency Ordinance (*reference here*). If greater than ½ acre proceed to Step Two to calculate the annual irrigation. Mini-oasis areas and low water use areas must be calculated separately. The maximum irrigation application rates apply.

Step Two: Calculate the portion of the total landscape in acres or square feet that are currently planted in “mini-oasis” plants. Retention/detention basins planted with turf or other high water use plants are considered part of the mini oasis allowance. Multiply that number by the maximum irrigation application rate (*4.6 acre feet per acre per year, or 34.4 gallons per square foot*) to determine the annual irrigation allotment for the mini-oasis area.

Refer to Step Three through Step Six above “Major Expansions or Renovations” to determine the annual irrigation allotment.

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TABLE - 1

SAMPLE SPREAD SHEET FOR ESTIMATING SITE IRRIGATION WATER USE AT MATURITY

Table-1 has been developed to assist the designer in estimating the water use for plants not on the ADWR Plant List and for Oasis plants. This spreadsheet is available on the following WEB site(s) _____, the electronic version automatically calculates water use at maturity based on the number of plants in each water use category in combination with mature canopy size. This spread sheet can also be used by the jurisdictions (who ever does the plan check) to determine if the planting design plan as submitted will likely stay within the irrigation water allotment for the site at maturity. **How it is used, where the spreadsheet is located e.g. Web site address etc. and an example of how it is filled out.**

SAMPLE MATRIX TO DETERMINE TO WATER USE FOR PLANT CATEGORIES															
Canopy Size diameter in feet	Plant 1 Water Require (in cubic ft.)	Quantity	Plant 1 Total	Plant 2 Water Require (in cubic ft.)	Quantity	Plant 2 Total	Plant 3 Water Require (in cubic ft.)	Quantity	Plant 3 Total	Plant 4 Water Require (in cubic ft.)	Quantity	Plant 4 Total	Mini-oasis Water Require (in cubic ft.)	Quantity	Mini-oasis Total (in gallons)
2	0			3			4			5			14		
4	0			10			16			21			57		
6	0			23			35			50			129		
8	0			42			63			83			229		
10	0			65			98			130			358		
12	0			94			141			188			516		
14	0			128			192			255			702		
16	0			167			250			334			917		
18	0			211			317			422			1161		
20	0			261			391			521			1433		
25	0			407			611			814			2240		
30	0			586			880			1173			3225		
35	0			798			1197			1596			4390		
Total Gallons															
Total Cubic Feet															

C. Landscape Design Plan

General Requirements

A landscape design plan meeting the following requirements must be submitted as part of the landscape documentation package.

- 1) Planting design must be consistent with all requirements of current landscape codes (Section #.). Existing facilities with ½ acre of pre-existing landscaped areas are not subject to landscape code requirements unless the landscape was installed after the effective date of the landscape ordinance(s) (varies by jurisdiction), except in areas where there has been a major renovation or expansion to the landscape areas.
- 2) Plant Selection - Except for the mini oasis area, plants must be selected from the approved Drought Tolerant/Low Water Use Plant list.
- 3) Plants that are not on the approved Drought Tolerant/Low Water Use Plant list, or that require spray irrigation cannot be used in street medians or public rights of way.
- 4) Plants having similar water use must be grouped together in distinct hydrozones. Consideration must also be given to variations in: exposure (e.g. microclimates); slope; and soil infiltration rates when determining hydrozones.
- 5) Plants must be selected appropriately based upon their adaptability to the climatic, geologic, and topographical conditions of the site.
- 6) Protection and preservation of native species and natural areas is subject to all requirements of the Native Plant Preservation Ordinance (NPPO).
- 7) A mulch (organic or inorganic) of at least three inches must be applied to all planting areas except turf. Placing non-porous material under the mulch is not allowed.

Landscape Plan Requirements

The landscape design plan must be drawn on project base sheets at a scale that accurately and clearly identifies: *Cities/County need to look at this list to see if they require other information not listed below when plans are submitted (Pima County is included in following list, things that are probably specific in the County are in italics)*

- 1) Project name, reference number, plan title and, where applicable, other special case reference number. *The title should include in parenthesis if the requirement is for a (Tentative Plat), (Final Plat), or (Development Plan)*
- 2) Name, address and phone number of preparer, license number and expiration date, if applicable.
- 3) North arrow, scale and location map and legal description (township, range, section).
- 4) Property lines, project limits, existing and proposed topographic lines and elevations, 100 year floodplain line and riparian habitats.

- 5) Existing and/or conditionally approved zoning of project; existing and approved use and zoning of adjacent properties; names and right-of-way width of adjacent roads. Label roads as public or private. Identify scenic routes.
- 6) The total square footage must be provided on the plan legend for each of the following: the site, the building and storage yard footprints, gross parking area, landscaping required (*reference appropriate code here*) and landscaping provided.
- 7) Indicate the square footage for each landscapable area and percent of mini oasis, separated by service meter and the total number of acres or square footage of landscapable area for the site on the plan legend. For example: if there are multiple landscape meters, the area served by each meter must be measured (in square feet) and the % of total site allotment determined for each area.
- 8) *Bufferyards:*
 - a. *The specific bufferyards required; the specific bufferyards provided;*
 - b. *All materials provided to satisfy bufferyard requirements: plants (either existing, relocated or newly introduced), sidewalks, berms, walls and wall heights, etc.; and*
 - c. *Square footage of total bufferyard area provided.*
- 9) All easements (utility, drainage, access, sewer, etc.) *Provide a letter of permission from holders of easement rights to allow for any landscaping within easements. When landscaping or bufferyards are required, or used within or near sewer easements, elements such as walls, fences, boulders and trees should be placed so they do not interfere with access to manholes, sewer lines, fire hydrants, or utility boxes.*
- 10) Designation of recreational areas.
- 11) Where applicable, parking area screening and planting, per **Chapter #**
- 12) Where applicable, a response to all conditions of rezoning or *Design Review Committee* approval that pertain to landscaping, vegetation preservation, revegetation, buffering, screening or other environmental concerns.
- 13) Designation of hydrozones. Address irrigation requirements in accordance with **Section #**. Specifically describe the method(s) and system(s) used.
 - a. A calculation of the total landscapable area.
 - b. A calculation of the total annual site irrigation allotment.
 - c. A calculation of the estimated applied irrigation water to establish the landscape.
 - d. A calculation of the estimated applied irrigation water for the landscape at maturity.
- 14) Graphically show the extent of disturbed/graded areas and all materials and elements provided for the revegetation and/or slope stabilization of these areas (including detention/retention basins, water harvesting features) *as required by the Grading Ordinance, Grading Design Manual and the Stormwater Detention/Retention Manual. For those projects requiring a Type II Grading Permit, provide a copy of the grading plan, or superimpose the landscape plan information on the grading plan.*
- 15) When grading plans or a combination paving/grading plan is required, the landscaping plans must be submitted (*to SCO*) concurrently with the first submittal of the grading plans (*to Transportation Planning and Development*).

- 16) Graphic representation of all landscape elements, including pools, ponds, water features, fences, and retaining walls; significant existing, preserved, relocated and introduced plant materials; inorganic groundcover; and architectural features and their functions. Also provide a graphic representation of natural features including, but not limited to, rock outcroppings, native vegetation and/or, existing trees, shrubs or groundcover that will remain.
- 17) Provide cross-corner sight distance triangles. Landscape materials must be selected and placed so as not to interfere with drivers' visibility within cross-corner sight distance triangles and within a visibility plane described by two horizontal lines located 30 inches and 72 inches above finished grade of the roadway surface.
- 18) A plant list and legend, indicating the scientific (botanical) and common name and total quantity of each plant, plant size, location and symbol, whether preserved, transplanted or introduced.
- 19) Specifications for tree staking, plant installation, soil preparation details, and any other applicable planting and installation details.
- 20) A design concept statement, plan notes or sketches that contain:
 - a. Plant selection. Plant materials with intrusive root systems cannot be placed within drainage basins with engineered bottoms.
 - b. Environmental zone and mini-oasis concepts, where applicable.
 - c. Irrigation. Groundwater, effluent and stormwater runoff detention and use; temporary or permanent systems.
 - d. Site grading and how it benefits landscaping. Where applicable, specifications for stockpiling and reapplying site topsoil or imported topsoil.
 - e. Use of groundcover or mulch (both organic and inorganic).
 - f. Use or disposal of existing, on-site vegetation and a statement indicating compliance with A.R.S. § 3-904 (Native Plant Law).
 - g. Address maintenance requirements in accordance with Section #. Specifically describe the maintenance and include a statement assuring the continued maintenance program of the required landscaping and assigning the responsibility of the maintenance to the property owner or agent, a homeowners' association or other liable entity.
- 21) If the plan is a phase or portion of an overall landscape plan the following will apply:
 - a. Boundary limits of the phase must be clearly noted on a copy of the overall plan.
 - b. Plant selection and design of the subsequent phases must conform to the overall plan and all applicable regulation
 - c. A revised landscape plan must be submitted if slope treatments, etc., are modified on the approved paving/grading plans.
- 22) As applicable, refer to the official rezoning conditions for other restrictions that may apply to landscape plans.

D. Irrigation Design Plan

An irrigation system can not be efficient unless the four factors of 1) system design, 2) installation, 3) management, and 4) maintenance are all adequately done. In general, irrigation systems must be designed to be site-specific, reflecting plant type, soil type, infiltration rates, slopes, microclimates and prevailing wind direction.

Irrigation System Requirements

- 1) Landscape Water Meters – must be installed at all new, expanded or renovated facilities and existing facilities upon change of ownership with landscapable or existing landscaped areas totaling one-half acre or more. *May want to say something here about variances for properties that have interconnected systems that cannot be separated without undue hardship to the property owner. Each jurisdiction should determine what a reasonable cost for improvements is and what constitutes a hardship on a site by site basis. Maybe if the cost of the meter and installation can be recovered within a 3-year payback period based on water/sewer fee reductions it would be reasonable? Could also require that in a “hardship situation” that they install a separate meter only on the new or renovated area, or multiple sub-meters as an option.*
- 2) New installations are required to meet the following minimum standards:
 - a) An average of 50% efficiency distribution uniformity (DU) as determined by a certified landscape irrigation auditor for turf irrigated with fixed spray style sprinklers.
 - b) An average of 65% efficiency DU as determined by a certified landscape irrigation auditor for turf irrigated with rotor style/sprinklers.
- 3) Sprinkler heads must conform to site conditions and be tested for uniformity of performance using the Center for Irrigation Technology’s (CIT) Sprinkler Profile and Coverage Evaluation (SPACE) program, or a comparable assessment acceptable to XXXX.
 - a) The sprinkler heads must have either distribution uniformity for the system, or, a sprinkler distribution profile that is 10% above the audit requirements.
 - b) Sprinkler heads must be installed according to the spacing and pressure range tested (not to exceed head to head spacing based on manufacturer’s performance data).
 - c) The results of this test must be provided to XXXX in a form acceptable to XXXX.
- 4) Irrigation systems must be designed such that water pressure at the sprinkler or emitter is appropriate to the design, available site water pressure and manufacturers’ specifications.
- 5) When necessary pressure may be regulated by the installation of a pressure regulating device or devices to reduce pressure, or booster pumps to increase pressure.
- 6) The irrigation system must be able to irrigate the site within the hours available for irrigation based on average historical Eto for June. Irrigation water must not leave the

- landscaped areas and flow onto adjacent pavement, public roads or sidewalks and other non-landscaped areas during an irrigation cycle.
- 7) Application equipment with different precipitation rates must not share a control valve and/or zone.
 - 8) Irrigation systems must be designed to be consistent with hydrozones. Each valve must irrigate a landscape hydrozone with similar site, slope and soil conditions and plant materials with similar watering needs. Trees must be placed on a separate valve from shrubs and groundcovers by hydrozone.
 - 9) Irrigation systems must be designed to eliminate low sprinkler or emitter line drainage. Under-the-head check valves, built in check valves, or in-line check valves must be installed as needed to prevent low head drainage and puddling.
 - 10) Drip irrigation filters and end flush valves must be provided as necessary for proper operation of the system.
 - 11) Sprinkler heads must be installed at least eight inches away from impermeable surfaces (e.g. sidewalks, buildings, walls, etc.). Refer to number 6 for clarification.
 - 12) Spray irrigation shall not be used in landscape areas less than twelve feet in any dimension except, where such an area is contiguous with adjacent property so that the dimension totals twelve feet minimum. These areas may be irrigated by drip, bubbler, soaker, or sub-surface irrigation systems.
 - 13) Irrigation systems will be controlled by an automatic controller in compliance with design standards and will be equipped with the following features:
 - (a) A sufficient number of programs to meet the irrigation scheduling requirements;
 - (b) Capable of programming run times in one-minute increments, up to 30 days between irrigations, and displaying the programmed run time as a numeric display;
 - (c) Non-volatile memory retention (irrigation schedule, time and date); Must be compatible with water conservation devices such as external rain switch interrupters, soil moisture sensors, and wind sensors.

Additional recommendations include the use of:

- (a) Percent options to reduce duration of irrigation within a program based on peak demand, for times of reduced demand.
 - (b) Soil moisture sensors since they directly impact irrigation scheduling, and therefore have a high potential to improve management efficiency.
 - (c) A central irrigation controller linked to actual Eto generated by a local weather station(s) on site, or closest to the site.
- 14) Lateral lines will be designed so the maximum pressure differential between the first sprinkler or emitter and the last sprinkler or emitter on the line does not exceed 20%.

- 15) Facility owners must submit a projected monthly irrigation schedule and annual water budget for each site. The annual water use based on an end of the year landscape meter reading cannot exceed the annual irrigation allotment for the mature landscape. If the site does not already have an assigned annual irrigation allotment, follow the procedures in Section V under “change of ownership” to calculate the irrigation allotment for the site.
- 16) Compliance with this provision is required before XXXX will issue a Certificate of Occupancy, or, in the case of park development a “Certificate of Substantial Completion” (or other per jurisdiction).
- 17) For longevity, the use of PVC drip irrigation lines is encouraged instead of the more commonly used polytube to reduce clogging of emitters due to root intrusion or damage by rodents.
- 18) Installation of master valves, flow sensors and automatic shutoffs is encouraged to minimize water loss due to main line breaks or leaks.

Irrigation Plan Requirements

The irrigation design plan must be drawn on project base sheets. It must be separate from, but use the same format as, the landscape design plan. The scale must be the same as that used for the landscape design plan described in Section #. The irrigation plan must accurately and clearly identify:

- 1) Location and size of separate water meter(s) for the landscape.
- 2) Layout of the irrigation system, (i.e. backflow prevention device, pressure regulator, automatic controller, main and lateral lines, valves, sprinklers, bubblers, drip emitters, quick couplers, and filters, where applicable)
- 3) A legend containing a general description of all components of the irrigation system, including: a) the manufacturer’s name and model number, b) operating pressure, c) manufacturer’s irrigation nozzle rating in gallons per minute (g.p.m.) or gallons per hour (g.p.h.), as necessary, d) minimum and maximum spray radius, e) calculated precipitation rate per nozzle, based on the irrigation plan.
- 4) The static water pressure in pounds per square inch (p.s.i.), at the point of connection to the public water supply (or to a water well where applicable).
- 5) Pressure calculation must be done on representative zones to assure adequate operating pressure.
- 6) Location, type, and size of all components of the irrigation system, including automatic controllers, main and lateral lines, valves, sprinkler heads, moisture sensing devices, rain switches, quick couplers, and backflow prevention devices.
- 7) Flow rate (in gallons per minute) and design operating pressure, p.s.i. for each valve; also, precipitation rates in inches per hour for each valve with sprinklers.

- 8) Installation details for irrigation components.
- 9) Recycled water irrigation systems and reclaimed water piping and guidelines as required, as specified in **Section #**

Irrigation Schedules

Irrigation Schedules satisfying the following conditions must be submitted as part of the Landscape Documentation Package:

- 1) An annual irrigation program with monthly irrigation schedules, are required for:
 - a) The plant establishment period,
 - b) The established landscape, and
 - c) Any temporarily irrigated areas.
 - d) A schedule for weaning water requirement category 1 plants (see approved plant list) from irrigation, if applicable.
- 2) The irrigation schedule must:
 - a) Be included on the irrigation plan as well as in the documentation package;
 - b) Include run time (in minutes per cycle), suggested number of cycles per day, frequency of irrigation for each station (weekly/monthly) and maximum operating hours per day for peak demand; and
 - c) Provide the amount of applied water (in hundred cubic feet, gallons, or in whatever billing units the local water supplier uses) recommended on a monthly and annual basis.
- 3) Whenever possible, irrigation scheduling will incorporate the use of evapotranspiration data such as those from the Arizona Meteorological Network (AZMET) weather stations to apply the appropriate levels of water for different climates.
- 4) Whenever possible, sprinkler irrigation will be scheduled to avoid irrigating during times of high wind or high temperature. This will reduce losses due to evaporation.

E. Maintenance Schedules

A regular maintenance schedule satisfying the following conditions must be submitted as part of the Landscape Documentation Package:

- 1) Maintenance must consist of regular watering, pruning, fertilizing, clearing of debris and weeds, the removal and replacement of dead plants, aerating and de-thatching turf areas; replenishing mulch in all landscaped areas and the repair of architectural features.

- 2) Pruning and thinning of foliage should not be done during hot months since it can increase plant water requirements (i.e. shading of the ground creates microclimates and reduces E_t rates.)
- 3) Landscapes must be maintained to ensure water efficiency, which must include but is not limited to regularly checking, adjusting, repairing and replacing of irrigation equipment. Schedules should include cleaning of filters and strainers, flushing of drip irrigation lines, adjusting sprinkler patterns to maintain uniformity, and calibrating all sensing and recording equipment. Repair or replacement of irrigation equipment should be done with the originally specified materials or their equivalents in order to meet the original specifications in the approved irrigation plan.
- 4) Monthly irrigation meter reading to check the landscape water use and resetting the automatic controller monthly to assure the site stays within its annual irrigation allotment. In addition, the battery and fuse in the controller should be checked and replaced when necessary.
- 5) Maintenance Assurances: The final approval of any subdivision plat or development plan that includes an approved final landscaping plan will require covenants or assurances that:
 - a) Ensure the continued maintenance of required landscaping, buffering and associated irrigation systems; and
 - b) Assign the responsibility of maintenance to the property owner or agent, homeowners' association or other liable entity.

F. Grading Design Plan

A Grading Design Plan, if required, satisfying the following conditions must be submitted as part of the Landscape Documentation Package:

- a) A grading design plan must be drawn on project base sheets. It must be separate from, but use the same format as, the landscape design plan.
- b) The plan must indicate finished configurations (pre-existing and new contour elevations) of the landscaped area(s), including the height of graded slopes, drainage patterns, pad elevations, and finish grade.

G. Soils

The Landscape Documentation Package must include the following soil analysis data:

- a) Determination of soil texture, indicating the percentage of organic matter.
- b) An approximate soil infiltration rate (either measured or derived from soil texture/infiltration rate tables.) A range of infiltration rates will be noted where appropriate.
- c) Measure of pH, and total soluble salts.

H. Reclaimed Water Use

For all parks, golf courses, median and right of way (R.O.W.) plantings, and other facilities developed after the effective date of this section, the owner or developer must, when available, use reclaimed wastewater or other non-groundwater water supplies for irrigation.

Jurisdictions will need to clarify how they are defining “availability” of supplies, and how reclaimed water use information is to be reported in the documentation package.

VI. POST INSTALLATION REQUIREMENTS

The following requirements must be met and verified by the *(insert appropriate jurisdiction/department here)* prior to final approval and occupancy:

A. Certifications

Reference pertinent section of the ordinance. Upon completing the installation of the landscaping and the irrigation system, it is the responsibility of the owner or the owner's authorized representative to:

- 1) Schedule an irrigation audit by a certified landscape irrigation auditor prior to the final field observation, and
- 2) Submit a Certificate of Substantial Completion to (city or county) A sample of such a form, which will be provided by (insert- city or county/department) follows. A licensed landscape architect or contractor, certified irrigation designer, or other licensed or certified professional in a related field will conduct a final field observation and will provide a certificate of substantial completion to (the city or county) within 10 working days of this inspection. The certificate must specifically indicate that:
 - (a) Plants were installed as specified,
 - (b) The irrigation system was installed as designed,
 - (c) The automatic controller has been set according to the irrigation schedule for the plant establishment period and:
 - (d) An irrigation audit has been performed, along with a list of any observed deficiencies.
 - (e) Any deficiencies have been corrected to comply with the audit specifications in (ordinance # reference here)

The (jurisdiction) reserves the right to perform site inspections at any time before, during or after irrigation system and landscape installation and to require corrective measures if requirements of the irrigation efficiency ordinance (reference here) are not met.

SAMPLE CERTIFICATE OF SUBSTANTIAL COMPLETION

Project Name: _____ Project Number: _____

Accessors Parcel Number: _____

Project Location/Address: _____

Preliminary Project Documentation Submitted: (check indicating submittal)

___ 1. Estimated total annual water budget for low water use plants:

___ acre feet per acre or gallons or cubic feet/year

___ 2. Estimated total annual water budget for mini oasis plants:

___ acre feet per acre or gallons or cubic feet/year

___ 3. Estimated Total Water Use for the Site

___ acre feet per acre or gallons or cubic feet/year

(add water allotments for low water use and mini oasis areas together)

___ 4. Estimated Site Budget - irrigation requirement for mature landscape

___ 5. Landscape Design Plan

___ 6. Irrigation Design Plan

___ 7. Irrigation Schedules

___ 8. Maintenance Schedule

___ 9. Landscape Irrigation Audit Report

Post-Installation Inspection: (Check indicating substantial completion)

___ Plants installed as specified

___ Irrigation system installed as designed

___ dual distribution system for recycled water

___ minimal run off or over-spray

___ the automatic controller has been set according to the irrigation schedule for the plant establishment period.

___ Landscape Irrigation Audit performed

___ Project submittal package including any as built modifications to the planting or irrigation system design and a copy of this certification has been provided to: the property owner or their authorized representative and (*planning department or local water agency?*)

Comments:

I/we certify that work has been installed in accordance with the contract documents.

(Typed) Contractor Name, Date, State License Number and expiration date

Contractor Signature

Address: _____

Phone: _____ Fax: _____

I/we certify that based upon periodic site observations, the work has been substantially completed in accordance with the Irrigation Efficiency Ordinance and that the landscape planting and irrigation installation conform with the approved plans and specifications.

(Typed) Landscape Architect or Certified Irrigation Designer Name, Date, State License Number and expiration date

Landscape Architect or Certified Irrigation Designer Signature

Address: _____

Phone: _____ Fax: _____

I/we certify that I/we have received all of the contract documents and that it is our responsibility to see that the project is maintained in accordance with the contract documents.

(Typed) Owners Name

Owner Signature, Date

Address: _____

Phone: _____ Fax: _____

Authority cited: Section

B. Landscape Irrigation Audit

Reference pertinent section in ordinance. May want to add contact info for the Irrigation Association so one could confirm if an auditor is certified and in good standing. Add a contact or identify the department that issues the certificate of occupancy.

- a) The site must have a Landscape Irrigation Audit performed by a Certified Landscape Irrigation Auditor, certified by the Irrigation Association prior to issuance of a certificate of occupancy.
- b) The auditor must be independent of the property owner and of all contractors associated with the property.
- c) The audits will be conducted in accordance with the current edition of the Landscape Irrigation Auditor's Handbook. The average distribution uniformity (d.u.) results for the site audit must be a minimum of 50% d.u. for all fixed spray systems, 65% d.u. for all rotary spray systems and 80% emission uniformity for drip irrigation.
- d) The results of the audit must be provided to XXXX in a letter or other form acceptable to XXXX and must be signed by the Auditor.
- e) Compliance with this provision is required before XXXX will issue new properties a Certificate of Occupancy, or, in the case of park development a Certificate of Substantial Completion.

C. Annual Reporting Requirements

Explain when, where and how they need to file the reports. May need to clarify why there is a reporting requirement; how the data might be used by the jurisdiction; who keeps these reports, for how long; and who has access to them.

Instructions... Explain where they can get a copy of the latest form. A sample annual report form follows:

SAMPLE

IRRIGATION EFFICIENCY ORDINANCE # ANNUAL REPORT FORM FOR COMMERCIAL LANDSCAPES

ANNUAL REPORT YEAR: _____ DATE ____/____/____

FACILITY INFORMATION

Facility Number _____

Facility Name _____

Facility Owner _____

Facility Address _____

City, State, Zip _____

Owner Phone _____

Reporting Party (if different than facility owner) _____

Contact Address _____

City, State, Zip _____

Legal Description (township, range and section) _____

What percent (must total 100%) of your irrigation water supply for this site is:

Potable water _____ % (from a water company or from private wells of drinking water quality)

C.A.P. water _____ %

Effluent or Reclaimed water _____ %

Other _____ %

Water source: i.e. name of supplying water company. If supply is from a private well include the registration number(s) for the well(s) and/or right number(s) _____

WATER METER READING

If your meter does not read in gallons, please convert the volume to gallons for this form.

A = Ending Meter Reading (in gallons) taken the last day of December _____ (gal)

B = Beginning Meter Reading (In Gallons) @ Installation, Or

the ending meter reading from previous year. Minus(-) _____ (gal)

Actual Annual Irrigation Water Use (gal) = (A - B) Total = _____ (gal)

Annual Site Irrigation Allotment (calculated during original site plan review): _____ gallons

Compare your irrigation water use to your annual site irrigation allotment. If you have exceeded your allotment, please provide an explanation or probable cause and what has or will be done to correct the problem.

Over

(Feel free to attach additional information if you need more space than provided below)

WATER USE INFORMATION- This Section Is Voluntary, But Your Cooperation Is Helpful For Research Purposes.

If the square footage of the landscapable areas for this site have been modified since installation or a mini-oasis was not included on the site please indicate below:

Actual Area of Low-Water-Use Planting (sq. ft.) = _____ (ft²)

Actual Area Of High-Water-Use Planting, Incl. Mini-Oasis (Sq. Ft.) = _____ (ft²)

Surface Area of Open Water (sq. ft.) ponds, fountains, swimming pools, etc., = _____ (ft²)

THIS SECTION FOR REVIEWING AGENCY USE ONLY

**DATA INPUT BY (NAME AND
DEPARTMENT)** _____

Compliance: _____

Notes:

VII. PUBLIC EDUCATION

The following information has been developed by local organizations such as the University of Arizona, Pima County Cooperative Extension, Low 4 Program. This information could be dispersed to appropriate employees and the public to increase their knowledge of how to maintain desert-adapted plants, properly schedule irrigation and maintain landscapes in the Sonoran desert.

Publications –maybe a fact sheet for those affected by the ordinance could be developed and distributed, it also could be distributed to title companies, realtors, SAHBA, etc. to get the word out. It could summarize the ordinance, who is affected and under what conditions, and where to call to get info.

DRAFT

WEANING DESERT-ADAPTED PLANTS FROM IRRIGATION

Deep water plants once a week for the first six (6) months following initial planting. Plants may need additional water for the first month to wean them from nursery irrigation. Trees should be watered to a three (3) foot depth, shrubs to a two (2) foot depth, and groundcovers to a one (1) foot depth.

To determine whether you are watering to the correct depth: turn your irrigation system on, check with a soil probe every half hour (poke the probe into the soil and it will stop when it hits the dry soil), when it gets to the three foot depth, turn your irrigation system off and note the time: that is your watering time for the tree valve for **every** watering. The interval **between** watering events will change but the watering time will remain constant for every irrigation.

If the plants are installed in the spring (January through May) they will be considered established after their second summer season. If the plants are installed in the fall (August through November) they will be considered established the following fall.

For three years after establishment the plants should be deep watered, to the correct depth for each type of plant, once (1) a week in the summer months, once (1) every two weeks in the fall and spring months, and once (1) a month during the winter months.

After three years the plants are to be deep watered, to the correct depth for each type of plant, twice a month in the summer months, once a month during the spring and fall, and not at all during the winter months. This schedule should continue for two years. ****Trees should be checked during this time for signs of stress. Symptoms are branch die back, slow growth, or no growth at all.**

For the next two years, deep water, to the correct depth, once a month in the summer months, every two months during the spring and fall, and not at all during the winter months.

After the seventh year the plants should be watched closely during the summer (they may need to be watered once a month) for signs of stress. Irrigation should not be removed ******

****Some plants, because of where they are situated in the landscape or the rooting situation may never be successfully weaned from irrigation, though a tree of the same species nearby may be weaned successfully. To avoid plant loss the plant material must be monitored closely, especially during the summer months. A property manager should expect to have to irrigate a small percentage of the landscape at times if this is the case or expect a percentage of plant failure. Trees may be more successful than other plants, but if they are not receiving irrigation they may compete for the water given to other plants and stress or failure may occur with the smaller plants.**

HOW TO DEVELOP A DRIP IRRIGATION SCHEDULE

EVALUATE SYSTEM PERFORMANCE

◆ Determine the precipitation rate of the system

- On each station, collect water in plastic gallon containers from at least three emitters with the same flow rate -- at the beginning, middle, and end of the line. Run each station for 30 minutes.
- Measure the water in the containers in gallons and multiply by two. This is the gallon-per-hour (gph) flow rate. The actual flow rate should be close to the manufacturer's flow rate for the emitter.
- All of the emitters tested should be putting out approximately the same amount of water. If flow rates are too low, check for clogged emitters, flush out the lines, and clean the filter. If flow rates are too high, the pressure regulator may not be working correctly.
- In most cases, differences in flow rates greater than 15% can be remedied by installation of pressure compensating emitters or additional pressure regulators.

DEVELOP THE SCHEDULE

How to Determine the Monthly Water Requirement

◆ Identify the largest size plant with the greatest water requirement on the station.

- For example, Aleppo Pine.

◆ Identify the plant as evergreen or deciduous, and as high, medium, or low water requirement. (Refer to: "Plant Water Requirements Tucson Arizona".)

- For example, Aleppo Pine is an evergreen tree with a low water requirement.

◆ Determine the canopy size of the plant. (The canopy is the measured diameter of the leafy part of the plant.)

- For example, an Aleppo Pine with a 14-foot canopy (diameter).

◆ Determine the current monthly water requirement in inches for the plant.

**LOW 4 Program
Pima County Cooperative Extension
Water Resource Research Center
350 N. Campbell Avenue
Tucson, Arizona 85719
Phone: 622-7701 FAX: 792-8518**

MONTHLY WATER REQUIREMENT IN INCHES - EVERGREEN PLANTS

WATER REQUIREMENT	J	F	M	A	M	J	J	A	S	O	N	D
Low	0	0	2"	2"	3"	3"	3"	2"	2"	2"	1"	0
Medium	0	0	3"	4"	5"	5"	5"	4"	4"	3"	2"	0
High	0	3"	5"	6"	8"	9"	7"	6"	6"	5"	3"	0

MONTHLY WATER REQUIREMENT IN INCHES - DECIDUOUS PLANTS

WATER REQUIREMENT	J	F	M	A	M	J	J	A	S	O	N	D
Low	0	0	0	2"	3"	3"	3"	2"	2"	0	0	0
Medium	0	0	0	4"	5"	5"	5"	4"	4"	0	0	0
High	0	0	0	6"	8"	9"	7"	6"	6"	5"	0	0

For example: Aleppo Pine-evergreen, low water requirement, June. The water requirement is 3 inches in June.

- ♦ Find the canopy size on the schedule below. Multiply the gallons required by the number of inches required for June to get the total gallons.

GALLONS/INCH REQUIRED BY CANOPY SIZE

FT	2	4	6	8	10	12	14	16	18	20	25	30
GAL per INCH	2	8	18	31	49	71	96	125	159	196	306	441

For example: Aleppo Pine, the canopy size is 14 feet. The gallons required in June for one inch of water is 96 gallons, the Aleppo Pine requirement of 3 inches is 288 gallons.

$$3 \text{ inches} \times 96 \text{ gallons/inch} = 288 \text{ gallons required in June}$$

How to Determine the Irrigation Time

- ◆ **Verify the number and flow rate of the emitters on the plant.**

- For example, the Aleppo Pine has 10 1-gph emitters.

- ◆ **To determine how many gallons each emitter should put out, divide the monthly requirement in gallons by the number of emitters.**

- For example, divide the 288 gallon requirement by 10.

$$288/10 = 29 \text{ gallons per emitter.}$$

- ◆ **To get the runtime, decide how many times to irrigate during the month.**

- For example, eight irrigations in June (twice a week). Divide 29 gallons by 8.

$$29/8 = 4 \text{ gallons per emitter}$$

Therefore, each runtime is 4 hours. (Two hours for 2-gph emitters.)

- ◆ **Repeat the procedure for each month of the year and each drip station.**

- Adjust the controller monthly.
- A water budget feature is an efficient way to change the schedule.

- ◆ **Determining irrigation frequency is the most difficult part of irrigation scheduling.**

- Soil texture is an important determinant of irrigation frequency. Use a soil probe to find out how fast the soil is drying out.
 - Clay soils will wet and dry slowly. Water for longer periods of time, but less frequently. Use emitters with low flow rates.
 - Sandy soils will wet and dry quickly. Water for shorter periods of time, but more frequently. Use emitters with high flow rates.
- Routine irrigation schedules are affected by unusual weather conditions, for example, prolonged periods of cloudiness or extreme heat. Irrigation frequency needs to be adjusted.
- Irrigation frequency is also affected by planting density, exposure, and plant rooting depth.
- This irrigation procedure does not account for rainfall. If rainfall is sufficient shut the controller off until the soil around the test plant has dried out by one-half, then turn it on. (Some controllers have a rain shut-off valve that will shut the controller off after sufficient rainfall, and then turn on the controller when the soil has dried out adequately.)

INSTALLING THE NEW SCHEDULE

◆ **Verify if the water is in the root zone.**

- Use a soil probe (piece of rebar or screwdriver) to determine if the entire root zone is wet after the station has run for the time specified. Probe the soil in several locations. The probe will stop when it reaches dry soil.
- Typical root zone depths for trees are 18"-36", shrubs 12"-24" and turf, ground cover, and bedding plants 6"-12". Lateral roots extend 1.5-4 times the diameter of the plant canopy.
- If the probe reaches beyond the root zone of the largest plants, the irrigation time is too long or the frequency is too often. In other cases, system maintenance may be required (leaks, clogged emitters, stuck valve).
- If the soil is dry, runtime or frequency may need adjusting.
- A mixture of wet and dry areas may indicate there are not enough emitters, emitters are not spaced properly, or emitters are clogged.
- If the new irrigation schedule calls for less frequent irrigation or shorter irrigation times than the previous schedule, the runtimes and the frequency should be decreased slowly so the plants have adequate time to adapt.

◆ **After the new schedule is installed, it may be possible to reduce water use an additional 10-20% and still maintain an attractive, healthy landscape.**

- Monitor further reductions carefully.

◆ **Consider the special conditions of each site.**

- Slopes, shade, high planting density, and other conditions make irrigation scheduling more difficult.
- Work with the irrigation system and observe the plant material.

SCHEDULING TECHNIQUES

◆ **Less frequent, deep irrigation is best.**

- Water to just below the root zone. Irrigation beyond the root zone is wasted water.
- In general, it is best to allow soils to dry out about 50% between irrigations.
- Short, frequent irrigation causes plants to develop shallow root zones which can result in tree blow-over. Short, frequent irrigation also creates salt accumulation in the root zone which can inhibit water uptake and damage plant tissues.

◆ **Inspect the general condition of plants on the line.**

- Signs of too much water include: wilted shoots, leaves that turn a lighter shade of green, brittle leaves, presence of algae and/or mushrooms.
- Signs of too little water include: yellowing and drop-off of older leaves, wilted leaves, curled leaves.

◆ **Leach Toxic Salts out of the Root Zone.**

- Over time, salts accumulate in the root zone. Leach the salts out of the root zone by running the station two or three times longer than normal once or twice a year. Less water is wasted if leaching is done following sufficient rainfall.

◆ **Plan for future plant growth.**

- Add additional emitters to accommodate new canopy and root growth. Space emitters so the irrigation pattern overlaps to reduce salt accumulation. If necessary increase the flow rate of emitters to provide more water.

SYSTEM MAINTENANCE AND REPAIR

◆ **Inspect the system regularly.**

- Inspect the drip system once a month for emitter plugging and leaks in the line. Tree roots can invade irrigation lines and animal and/or human activity can also damage irrigation equipment. Make needed repairs.
- Flush the system and clean the filter once a year. To flush, remove the end cap closest to the valve and let the system run for at least 30 seconds or more. Follow this procedure until all end caps have been flushed.

VIII. COMPLIANCE AND ENFORCEMENT

This part of the guidance manual could clarify who is responsible for compliance with this ordinance (landowner? tenant if they are responsible for the grounds?). Which department is responsible for checking compliance or enforcing investigations of complaints? Each jurisdiction could reference and explain consequences of non-compliance, appeals process, etc.

1. Planning and development services department personnel, qualified in landscape architectural review will periodically spot-inspect landscape installations for compliance with this chapter and approved landscape plans.
2. When properties change ownership, compliance with the irrigation efficiency ordinance standards will be required **(insert Ordinance Reference #.)**.

The new owner is responsible for:

- a) Installation of separate irrigation water meter(s) on the site.
 - b) Calculation and submittal of the irrigation water budget for the site based on existing landscaping and “Target Conservation Budget”.
 - c) Submittal of annual water use report to (insert appropriate jurisdiction and department here).
3. A third party landscape audit of new development and expansions or major renovations to commercial, industrial and publicly owned facilities, common areas in multi-family and master planned communities, parks, cemeteries and athletic fields having a minimum of ½ acre of landscapable area is required. Audits should be submitted to (insert the governing jurisdiction/department here).
 4. Requires filing of annual water use reports by the property owner of the regulated facilities, or their authorized representative, by **(insert deadline for filing here)**. End of the year readings of the site irrigation meter(s) will be checked against their respective allotments by (insert appropriate department here) to determine compliance with the site annual irrigation allotment.

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Appendix A- Water Measurement and Conversion Factors

Water Measurements:

$$1 \text{ gallon} = 8.34 \text{ pounds}$$

$$1 \text{ cubic foot} = 7.48 \text{ gallons}$$

$$1 \text{ unit (Ccf)} = 748 \text{ gallons} = 100 \text{ cubic feet}$$

$$1 \text{ acre foot} = 325,581 \text{ gallons} = 43,560 \text{ cubic feet}$$

$$1 \text{ second foot} = 7.48 \text{ gallons/second} = 1 \text{ cubic foot/second}$$

Conversion Factors:

Acres to Square Feet

$$(43,560 \text{ square feet/acre}) (\text{acres}) = \text{square feet}$$

Square Feet to Acres

$$\text{acres} = \frac{\text{square feet}}{43,560 \text{ sq. ft./acre}}$$

Inches of Water to Gallons

$$(0.623 \text{ gallons/square foot inch}) (\text{inches of water}) = \text{gallons/square feet}$$

ET of a Specific Crop:

$$ET_c = ET_o \times K_c$$

Where:

ET_c = ET rate of a specific crop

ET_o = reference evapotranspiration

K_c = crop coefficient

Landscape Coefficient:

$$k_l = (k_s)(k_d)(k_{mc})$$

Where:

k_l = landscape coefficient

k_s = species factor

k_d = density factor

k_{mc} = microclimate factor

Historic Evapotranspiration Rates, Tucson, Arizona - Sample Spreadsheet

In this example the total site allotment is 150,000 gallons. Using historic evapotranspiration averages, if the total site allotment is divided by the percent of the total eto for each month it gives a general idea of the amount of water that should be applied monthly to stay within the site water allotment, Adjustments for variations in weather and microclimates should be made on a site by site basis.

Average ET 1986-2000. AZMET data			
			input total site allotment in gallons
Month	ETo - Effective rainfall	Percent of Total	Example:150,000 gallon allotment
Jan	3.03	3.89%	5,833
Feb	3.77	4.85%	7,268
Mar	6.00	7.71%	11,566
Apr	8.09	10.39%	15,592
May	9.92	12.74%	19,115
Jun	10.56	13.56%	20,343
Jul	9.27	11.91%	17,872
Aug	8.01	10.28%	15,426
Sep	7.24	9.31%	13,960
Oct	5.78	7.42%	11,129
Nov	3.58	4.60%	6,897
Dec	2.59	3.33%	4,999
TOTAL	77.84		150,000

Appendix B - Irrigation System Inspection Form

STATION	FACILITY: CONTROLLER DESIGNATION: CONTROLLER LOCATION:	IRRIGATION TYPE	BROKEN HEADS	CLOGGED HEADS	MISSING HEADS	SUNKEN HEADS	HIGH VEGETATION	HEADS NOT VERTICAL	MIXED HEADS	MIXED NOZZLES	HIGH PRESSURE	LOW PRESSURE	OVERSPRAY	VARIABLE SPACING
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														

SPRINKLER IRRIGATION EQUIPMENT PERFORMANCE CHECKLIST

PROBLEM	WHAT TO LOOK FOR	SOLUTIONS
Clogged/broken/ missing nozzles or heads	Brown spots. Standing water. Incorrect spray pattern. Water-stained asphalt or sidewalk.	Replace missing or broken heads and nozzles. Replace with the same type and performance head. Clean clogged nozzles. Select matched precipitation rate heads and nozzles. Institute a weekly after-mowing inspection routine.
Malfunctioning wiper seals	Water spraying from base of head.	Replace wiper seal or replace entire head with same type and brand.
Heads blocked by grass. Sunken heads.	Standing water. Brown spots. Reduced throw. Distorted spray pattern.	Reduce mowing height. Raise sprinkler level to the soil grade.
Head rotation out of adjustment	Brown spots. Excessively wet areas.	Adjust head so that each head is rotating correctly and at the same rate.
Heads not vertical or flush with grade	Standing water. Brown spots.	Adjust sprinklers to a vertical position that is flush with the soil grade. Compact soil tightly around the head. Swing joint installation may be required.
Mixed heads	Different spray patters and rotations. Brown spots. Excessively wet spots.	Determine original design head and nozzle. Replace all heads with original heads and nozzles.
Low head drainage	Draining water after system is turned off. Excessively wet spot.	Install check valves at low heads.
Low pressure	Water sprays in large droplets. Rotor sprays rotate slowly. Pop-up sprays slow to rise. Green "doughnuts" around head.	Install lower flow nozzles. Make sure two stations are not operating at the same time. Increase the setting at the pressure reducing valve. Check for broken pipes or fittings. Reduce number of heads on the line and install another valve. Increase the size of line components. Install booster pump.
High pressure	Water mists, drifts, and evaporates. Overspray on paved areas.	Install pressure regulating valve. Turn the flow control stem down. Use spray nozzles with pressure compensating devices. Install pressure compensating inserts in spray head.
Overspray	Standing water on paving. Water stains and damage on paving.	Reduce pressure. Adjust arc pattern of head. Move spray heads 4-6 inches from edge of paving. Move larger radius heads 10 inches in.
Variable spacing	Brown spots. "Scallops." Excessively wet areas.	Adjust nozzles and pressure. Determine manufacturer's recommended spacing. Relocate and add heads. Or change to heads or nozzles that perform at the measured spacing and pressure.
Broken pipe or fittings	Standing water. A washed-out hole.	Fix pipe. Replace fittings with a flexible swing joint. Flush soil from system.

Appendix C

ARIZONA DEPARTMENT OF WATER RESOURCES - TUCSON AMA LOW WATER USE/DROUGHT TOLERANT PLANT LIST FOR IRRIGATION EFFICIENCY

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Abronia villosa</i>	Sand verbena	3	1	1	0	0
<i>Acacia abyssinica</i>	Abyssinian Acacia	30	25	3	15	6,579
<i>Acacia aneura</i>	Mulga	10	20	2	10	487
<i>Acacia angustissima</i>	White Ball Acacia	5	5	2	10	122
<i>Acacia berlandieri</i>	Guajillo	15	15	3	15	1,645
<i>Acacia constricta</i>	Whitethorn Acacia, Mescat	20	20	1	0	0
<i>Acacia crasspedocarpa</i>	Waxleaf Acacia	15	15	1	0	0
<i>Acacia cultriformis</i>	Knife-Leaf Acacia	15	15	2	10	1,097
<i>Acacia greggii</i>	Cat's Claw Acacia	20	15	1	0	0
<i>Acacia farnesiana</i>	Southwestern Sweet Acacia	25	25	2	10	3,046
<i>Acacia notabilis</i>	Notable Acacia	15	8	2	10	1,097
<i>Acacia redolens</i>	Prostrate Acacia	12	5	2	10	702
<i>Acacia rigidula</i>	Black Brush Acacia	9	15	3	15	592
<i>Acacia salicina</i>	Willow Acacia	30	40	2	10	4,386
<i>Acacia saligna</i>	Weeping Wattle	20	25	2	10	1,949
<i>Acacia schaffneri</i>	Twisted Acacia	25	20	2	10	3,046
<i>Acacia stenophylla</i>	Pencilleaf Acacia	20	30	2	10	1,949
<i>Acacia willardiana</i>	Palo Blanco	10	20	2	10	487
<i>Agave americana</i>	Century Plant	8	7	2	10	312
<i>Agave colorata</i>	Mescal Ceniza	3	3	1	0	0
<i>Agave filifera</i>	Agave	3	2	2	10	44
<i>Agave geminiflora</i>	Twin-flowered Agave	3	3	2	10	44
<i>Agave huachucensis</i>	Huachuca Agave	4	4	2	10	78
<i>Agave lophantha (univittata)</i>	Holly Agave	6	3	2	10	175
<i>Agave ocahui</i>	Ocahui Agave	3	3	2	10	44

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Agave palmeri</i>	Palmer Agave	4	4	1	0	0
<i>Agave parryi</i> v. <i>truncata</i>	Artichoke Agave	3	3	2	10	44
<i>Agave victoriae-reginae</i>	Victoria Regina Agave	2	1	2	10	19
<i>Agave vilmoriniana</i>	Octopus Agave	8	4	2	10	312
<i>Aloe barbadensis</i>	Aloe vera	2	2	3	15	29
<i>Aloe ferox</i>	Cape Aloe	3	15	3	15	66
<i>Aloe saponaria</i>	Mediterranean Aloe	12	1	2	10	702
<i>Aloe variegata</i>	Partridge Breast Aloe	1.5	1	3	15	16
<i>Aloysia gratissima</i>	Fragrant Bush, Bee Brush	8	6	2	10	312
<i>Aloysia wrightii</i>	Wright's Bee Bush	4	4	2	10	78
<i>Ambrosia</i> (Franseria) <i>deltoidea</i>	Triangle-leaf Bursage	3	3	1	0	0
<i>Ambrosia</i> (Franseria) <i>dumosa</i>	White Bursage	3	3	1	0	0
<i>Anisacanthus thurberi</i>	Desert Honeysuckle	4	6	2	10	78
<i>Antigonon leptopus</i>	Queen's Wreath	20	20	3	15	2,924
<i>Aristida purpurea</i>	Purple Three-awn	1	2	1	0	0
<i>Asclepias linaria</i>	Pineleaf Milkweed	3	3	2	10	44
<i>Asclepias subulata</i>	Desert Milkweed	3	3	2	10	44
<i>Aster bigelovii</i>	Aster	.5	1-3	1	0	0
<i>Aster tanacetifolius</i>	Aster	.5	1.5	1	0	0
<i>Atriplex canescens</i>	Four-Wing Saltbush	8	8	1	0	0
<i>Atriplex lentiformis</i>	Quail Bush	15	10	1	0	0
<i>Atriplex lentiformis breweri</i>	Brewer Saltbush	10	10	2	10	487
<i>Atriplex nummularia</i>	Old Man Saltbush	15	9	1	0	0
<i>Atriplex polycarpa</i>	Desert Saltbush	6	3	1	0	0
<i>Atriplex semibaccata</i>	Australian Saltbush	6	1	2	10	175
<i>Baccharis sarothroides</i> 'Centennial'	Centennial Desert Broom	9	2	3	15	592
<i>Baccharis sarothroides</i> (male plants only)	Desert Broom	9	9	2	10	395

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
Bahia absinthifolia	Desert Daisy	1	1	2	10	5
Baileya multiradiata	Desert Marigold	1	1	2	10	5
Berberis harrisoniana	Barberry	3	3	3	15	66
Berberis trifoliata	Agritos	8	8	3	15	468
Bothriochloa barbinodis	Cane Beardgrass	2	3	1	0	0
Bougainvillea spp.	Bougainvillea	20	20	3	15	2,924
Bouteloua chondrosioides	Sprucetop Grama	1	1.5	2	10	5
Bouteloua curtipendula	Sideoats Grama	1	2	1	0	0
Bouteloua eriopoda	Black Grama	1	1	3	15	7
Bouteloua gracilis	Blue Grama	1	2	2	10	5
Bouteloua hirsuta	Hairy Grama	1	1	2	10	5
Bouteloua rothrockii	Rothrock Grama	1	1	1	0	0
Brachychiton populneus	Bottle Tree	30	45	3	15	6,579
Brahea (Erythea) armata	Mexican Blue Palm	10	30	3	15	731
Buchloe dactyloides	Buffalo Grass	5	1.5	3	15	2
Buddleia marrubifolia	Wooly Butterfly Bush	5	5	3	15	183
Bulbine frutescens	Shrubby bulbine	1.5	1.5	2	10	11
Caesalpinia (Poinciana) gilliesii	Yellow Bird of Paradise	6	10	2	10	175
Caesalpinia (Poinciana) mexicana	Mexican Bird of Paradise (yellow)	10	15	2	10	487
Caesalpinia pulcherrima	Red Bird of Paradise	6	10	3	15	263
Calliandra californica	Red Fairy Duster, Baja Fairy Duster	6	5	3	15	263
Calliandra eriophylla	Fairy Duster, False Mesquite	4	3	1	0	0
Calliandra peninsularis	Red Calliandra, Baja Fairy Duster	6	6	3	15	263
Callistemon citrinus	Lemon Bottlebrush	10	15	3	15	731
Calylophus hartwegii	Calylophus	3	1.5	3	15	66
Campsis radicans	Common Trumpet Creeper	20	20	3	15	2,924
Carnegiea gigantea	Saguaro	25	50	1	0	0

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Carpobrotus edulis</i>	Ice Plant	6	1	3	15	263
<i>Cassia artemisioides</i>	Wormwood Senna, Feathery Cassia	5	5	3	15	183
<i>Cassia nemophila</i> (eremophila)	Green Cassia	6	9	2	10	175
<i>Cassia phyllodinea</i>	Silvery Cassia	6	6	3	15	263
<i>Casuarina cunninghamiana</i>	Australian Pine	35	70	3	15	8,955
<i>Casuarina stricta</i>	Coast Beefwood	25	35	3	15	4,569
<i>Catalpa x chilopsis</i>	Chitalpa	20	25	4	20	3,899
<i>Cathostecum erectum</i>	False Grama			1	0	#VALUE!
<i>Celtis pallida</i>	Spiny or Desert Hackberry	10	16	2	10	487
<i>Celtis reticulata</i>	Netleaf or Western Hackberry	30	30	2	10	4,386
<i>Centaurea cineraria</i>	Dusty Miller	3	3	3	15	66
<i>Cephalophyllum aestonii</i> 'Red Spike'	Red Spike Ice Plant	1.5	0.5	2	10	11
<i>Ceratonia siliqua</i>	Carob, St. John's Bread Tree	40	40	3	15	11,697
<i>Cercidium floridum</i>	Blue Palo Verde	30	30	2	10	4,386
<i>Cercidium hybrid</i> "Desert Museum"	Desert Museum Palo Verde	30	30	1	0	0
<i>Cercidium microphyllum</i>	Littleleaf or Foothill Palo Verde	20	20	1	0	0
<i>Cercidium praecox</i>	Palo Brea	25	30	2	10	3,046
<i>Cercidium sonora</i>	Sonoran Palo Verde	20	20	2	10	1,949
<i>Cercis canadensis mexicana</i>	Mexican Redbud	15	15	3	15	1,645
<i>Cereus peruvianus</i>	Peruvian Cereus	10	20	2	10	487
<i>Chamaerops humilis</i>	Mediterranean Fan Palm	10	15	3	15	731
<i>Chilopsis linearis</i>	Desert Willow	30	30	2	10	4,386
<i>Chrysactinia mexicana</i>	Damianita Daisy	3	2	3	15	66
<i>Cissus incisa</i>	Desert Grape Ivy	20	20	1	0	0
<i>Cissus trifoliata</i>	Desert Grape Ivy	20	20	1	0	0

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
Condalia warnockii var. kearneyana	Condalia	5	6	1	0	0
Convolvulus cneorum	Bush Morning Glory	3	2	2	10	44
Convolvulus mauritanicus	Ground Morning Glory	2	.5	3	15	29
Cordia boissieri	Anacahuita, Texas Olive	15	15	2	10	1,097
Cordia parvifolia	Littleleaf Cordia	10	8	1	0	0
Cortaderia selloana	Pampas Grass	10	15	3	15	731
Cupressus arizonica	Arizona Cypress	20	50	2	10	1,949
Cupressus glabra	Smooth Bark Cypress	20	40	2	10	1,949
Dalbergia sissoo	Rosewood	30	50	3	15	6,579
Dalea bicolor argyrea	Silver Dalea	4	4	2	10	78
Dalea capitata	Yellow Dalea	3	1	3	15	66
Dalea frutescens	Black Dalea	5	4	2	10	122
Dalea greggii	Trailing Indigo Bush	9	2	2	10	395
Dalea pulchra	Indigo Bush	5	6	2	10	122
Dalea versicolor var. sessilis	Indigo Bush, Dalea	5	4	3	15	183
Dasyllirion acrotriche	Green Desert Spoon	5	4	1	0	0
Dasyllirion longissimum	Toothless Desert Spoon	5	4	2	10	122
Dasyllirion wheeleri	Sotol, Desert Spoon	5	4	1	0	0
Datura wrightii	Sacred Datura	6	3	3	15	263
Digitaria californica	Arizona Cottontop	1.5	3	1	0	0
Dimorphotheca sinuata	African Daisy, Cape Marigold	0.5	0.5	4	20	2
Dodonaea viscosa	Hopbush	12	15	1	0	0
Dyssodia acerosa	Dogweed	.5	.5	2	10	1
Dyssodia pentachaeta	Golden Dyssodia	0.5	0.5	2	10	1
Echinocactus grusonii	Golden Barrel	2	3	3	15	29
Echinocereus spp.	Hedgehog, Rainbow Cactus	2	2	1	0	0
Echinopsis spp.	Easter Lily, Sea	2	2	1	0	0

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
	Urchin Cactus					
Encelia californica	California Brittlebush (green)	4	4	1	0	0
Encelia farinosa	Brittlebush	3	3	1	0	0
Ephedra nevadensis	Ephedra	4	5	3	15	117
Eragrostis intermedia	Plains Lovegrass	1	3	1	0	0
Eremophila decipiens	Emu Bush	5	5	1	0	0
Erioneuron pulchellus	Fluffgrass	.5	.5	1	0	0
Eschscholtzia californica	California Poppy	2	2	2	10	19
Eschscholtzia mexicana	Mexican Gold Poppy	1	1	3	15	7
Eucalyptus camaldulensis	Red River Gum	50	120	2	10	12,184
Eucalyptus campaspe	Silver Gimlet	25	35	2	10	3,046
Eucalyptus formanii	Eucalyptus	20	20	2	10	1,949
Eucalyptus leucoxydon (rosea)	White Iron Bark	30	40	2	10	4,386
Eucalyptus microtheca	Tiny Capsule Eucalyptus	35	35	1	0	0
Eucalyptus polyanthemus	Silver Dollar Gum	30	40	2	10	4,386
Eucalyptus rudis	Desert Gum	50	100	2	10	12,184
Eucalyptus spathulata	Swamp Mallee	20	20	3	15	2,924
Euphorbia antisiphilitica	Wax Plant, Candelilla	3	3	1	0	0
Euphorbia myrsinites	Euphorbia	3	1	2	10	44
Euphorbia rigida (biglandulosa)	Gopher Plant	3	2	2	10	44
Eysenhardtia orthocarpa	Kidneywood	10	10	3	15	731
Eysenhardtia texana	Texas Kidneywood	8	8	3	15	468
Feijoa sellowiana	Pineapple Guava	15	15	3	15	1,645
Ferocactus spp.	Compass Barrel Cactus	1.5	5	1	0	0
Fouquieria splendens	Ocotillo	8	15	1	0	0
Gaillardia pulchella	Fire Wheel, Blanket Flower	1.5	1.5	3	15	16
Gazania rigens	Treasure Flower	1	1	3	15	7

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
	Gazania					
Gazania rigens leucolaena	Trailing Gazania	1.5	1	3	15	16
Geijera parviflora	Australian Willow	20	25	3	15	2,924
Geoffreyia (Gourleia) decorticans	Chilean Palo Verde	15	20	1	0	0
Gossypium harknessii	Gossypium	3	3	2	10	44
Haplopappus (Ericameria) laricifolius	Turpentine Bush	4	2.5	1	0	0
Hesperaloe funifera	Giant Hesperaloe	5	5	1	0	0
Hesperaloe parviflora	Red Yucca	4	3	1	0	0
Heteropogon contortus	Tanglehead	2	3	3	15	29
Hibiscus coulteri	Yellow Hibiscus, Coulter's Hibiscus	3	3	2	10	44
Hilaria berlandieri	Curly mesquite	1	.5	2	10	5
Hilaria mutica	Tobosa grass	2	2	1	0	0
Hilaria rigida	Big galleta grass	1	3	2	10	5
Hymenoxys acaulis	Angelita Daisy	1	1	3	15	7
Hyptis emoryi	Desert Lavendar	8	8	3	15	468
Jatropha cardiophylla	Limberbush	4	3	1	0	0
Jatropha dioica	Jatropha	3	3	1	0	0
Juniperus chinensis	Juniper (many cultivars)	10	20	3	15	731
Juniperus deppeana	Alligator Bark Juniper	30	40	3	15	6,579
Juniperus sabina	Sabine Juniper	8	1.5	3	15	468
Justicia (Beloperone) californica	Chuparosa	4	3	2	10	78
Justicia candicans	Red Jacobinia	3	5	3	15	66
Justicia spicigera	Firecracker Bush	4	4	3	15	117
Lantana camara	Bush Lantana (many cultivars)	4	3	3	15	117
Lantana montevidensis	Trailing Lantana	6	1.5	3	15	263
Larrea tridentata (divaricata)	Creosote Bush, Greasewood	12	12	1	0	0

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Leptochloa dubia</i>	Green Sprangle-Top	1	3	3	15	7
<i>Leucaena retusa</i>	Golden Leadball	15	20	1	0	0
<i>Leucophyllum</i> spp.	Texas Ranger (all cultivars)	5	3-10	2	10	122
<i>Linum grandiflorum</i> 'Rubrum'	Scarlet Flax	1	2	3	15	7
<i>Linum lewisii</i>	Blue Flax	1	2	3	15	7
<i>Lupinus arizonicus</i>	Lupine	1	2	1	0	0
<i>Lupinus sparsiflorus</i>	Desert Lupine	1	2	1	0	0
<i>Lupinus succulentus</i>	Arroyo Lupine	1	3	1	0	0
<i>Lycium exsertum</i>	Thornbush	8	8	1	0	0
<i>Lycium fremontii</i>	Wolfberry	8	10	1	0	0
<i>Lysiloma thornberi</i>	Feather Bush	30	30	2	10	4,386
<i>Macfadyena unguis-cati</i>	Cat's Claw Vine	30	30	2	10	4,386
<i>Malephora crocea</i>	Croceum, Ice Plant	6	1	2	10	175
<i>Mamillaria</i> spp.	Mamillaria Cactus	0.5	0.5	1	0	0
<i>Mascagnia lilacina</i>	Lavender Orchid Vine	10	15	2	10	487
<i>Mascagnia macroptera</i>	Yellow Orchid Vine	25	25	2	10	3,046
<i>Maytenus phyllanthoides</i>	Mangle Dulce	12	12	2	10	702
<i>Melampodium leucanthum</i>	Blackfoot Daisy	2	2	2	10	19
<i>Merremia aurea</i>	Yellow Merremia	25	25	2	10	3,046
<i>Mimosa dysocarpa</i>	Velvetpod	6	6	2	10	175
<i>Muhlenbergia dumosa</i>	Bush Muhlenbergia, Bamboo Muhly	6	6	3	15	263
<i>Muhlenbergia emersleyi</i>	Bullgrass	5	5	1	0	0
<i>Muhlenbergia porteri</i>	Bush muhly	3	1	1	0	0
<i>Muhlenbergia rigens</i>	Deer grass	5	5	3	15	183
<i>Muhlenbergia rigida</i>	Muhlenbergia	3	5	3	15	66
<i>Myoporum parvifolium</i>	Myoporum	9	0.5	3	15	592
<i>Myrtus communis</i> 'Boetica'	Twisted Myrtle	8	12	3	15	468
<i>Myrtus communis</i> 'Compacta'	Dwarf Myrtle	6	6	3	15	263

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Myrtus communis</i>	True Myrtle, Roman Myrtle	5	6	3	15	183
<i>Nandina domestica</i>	Heavenly Bamboo (many cultivars)	4	6	3	15	117
<i>Nerium oleander</i>	Oleander (many cultivars)	12	20	2	10	702
<i>Nolina bigelovii</i>	Beargrass	4	6	1	0	0
<i>Nolina matapensis</i>	Tree Beargrass	6	25	1	0	0
<i>Nolina microcarpa</i>	Beargrass	6	3	1	0	0
<i>Nolina parryi</i>	Parry's Beargrass	5	5	1	0	0
<i>Oenothera berlandieri</i>	Mexican Evening Primrose	3	1	3	15	66
<i>Oenothera caespitosa</i>	Tufted Evening Primrose	2	1	2	10	19
<i>Oenothera stubbei</i>	Baja Primrose	4	0.5	2	10	78
<i>Olea europaea</i> 'Swan Hill'	Swan Hill Olive	30	30	3	15	6,579
<i>Olneya tesota</i>	Desert Ironwood, Tesota	25	30	1	0	0
<i>Opuntia</i> spp.	Prickly Pear, Cholla	6	4	1	0	0
<i>Oryzopsis hymenoides</i>	Indian Ricegrass	2	2	3	15	29
<i>Osteospermum fruticosum</i>	Trailing African Daisy	4	1	3	15	117
<i>Pappophorum mucronulatum</i>	Pappusgrass	2	3	1	0	0
<i>Parkinsonia aculeata</i>	Mexican Palo Verde	35	35	1	0	0
<i>Passiflora foetida</i>	Passion Flower	10	10	3	15	731
<i>Pedilanthus macrocarpus</i>	Slipper Flower	2	3	2	10	19
<i>Pennisetum setaceum</i> 'Cupreum'	Purple Fountain Grass	5	4	1	0	0
<i>Penstemon ambiguus</i>	Pink Plains Penstemon	1	3	2	10	5
<i>Penstemon baccharifolius</i>	Cutleaf Penstemon	1	1	2	10	5
<i>Penstemon barbatus</i>	Beardtongue Penstemon	3	2	2	10	44
<i>Penstemon eatoni</i>	Eaton's Penstemon	3	2	2	10	44

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Penstemon palmeri</i>	Palmer Penstemon	3	2	2	10	44
<i>Penstemon parryi</i>	Parry Penstemon	3	2	2	10	44
<i>Penstemon pseudospectabilis</i>	Mohave Beardtongue	3	2	2	10	44
<i>Penstemon superbus</i>	Superb Penstemon	4	2	2	10	78
<i>Pentzia incana</i>	Karoo Bush	3	1	1	0	0
<i>Phacelia campanularia</i>	Desert Canterbury Bells	1	1	2	10	5
<i>Phacelia tanacetifolia</i>	Tansy Phacelia	1	1	2	10	5
<i>Phoenix canariensis</i>	Canary Island Date Palm	30	60	3	15	6,579
<i>Phoenix dactylifera</i>	Date Palm	20	100	3	15	2,924
<i>Phyla nodiflora</i>	Lippia	0.5	.125	3	15	2
<i>Pinus edulis</i>	Piñon Nut Pine	15	25	2	10	1,097
<i>Pinus eldarica</i>	Afghan Pine	25	50	2	10	3,046
<i>Pinus halepensis</i>	Aleppo Pine	60	80	2	10	17,545
<i>Pinus monophylla</i>	Singleleaf Piñon Pine	15	25	2	10	1,097
<i>Pinus pinea</i>	Italian Stone Pine	50	60	2	10	12,184
<i>Pinus roxburghii</i>	Chir Pine	40	80	3	15	11,697
<i>Pistacia atlantica</i>	Mt. Atlas Pistache	50	60	2	10	12,184
<i>Pistacia chinensis</i>	Chinese Pistache	50	60	3	15	18,276
<i>Pistacia terebinthus</i> x <i>integerrima</i>	Pistache hybrid tereb. x integerrima	30	30	3	15	6,579
<i>Pistacia vera</i>	Pistachio	30	30	2	10	4,386
<i>Pithecellobium flexicaule</i>	Texas Ebony	20	30	2	10	1,949
<i>Pithecellobium mexicanum</i>	Mexican Ebony	30	30	3	15	6,579
<i>Pithecellobium pallens</i>	Tenaza	12	30	2	10	702
<i>Pittosporum phillyraeoides</i>	Willow Pittosporum	15	20	2	10	1,097
<i>Pittosporum tobira</i> (cultivar)	Mock Orange	10	6	3	15	731
<i>Plantago</i> spp.	Indian Wheat	0.5	.25-2	1	0	0
<i>Poliomintha maderensis</i>	Lavendar Spice	2	2	3	15	29
<i>Prosopis</i> (So. Am. hybrid)	Thornless Mesquite	40	30	2	10	7,798
<i>Prosopis alba</i>	Argentine Mesquite	40	40	2	10	7,798

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Prosopis chilensis</i>	Chilean Mesquite	40	40	2	10	7,798
<i>Prosopis glandulosa glandulosa</i>	Honey or Texas Mesquite	30	30	2	10	4,386
<i>Prosopis pubescens</i>	Screwbean Mesquite	20	20	2	10	1,949
<i>Prosopis velutina</i>	Velvet Mesquite	30	30	2	10	4,386
<i>Psilostrophe cooperi</i>	Paper Flower	2	2	2	10	19
<i>Psilostrophe tagetina</i>	Paper Flower	2	2	2	10	19
<i>Punica granatum</i>	Pomegranate	15	20	2	10	1,097
<i>Pyracantha</i> (red berried types)	<i>Pyracantha</i> (many cultivars)	12	20	3	15	1,053
<i>Quercus arizonica</i>	Arizona White Oak	30	60	3	15	6,579
<i>Quercus buckleyi</i>	Texas Red Oak	30	30	2	10	4,386
<i>Quercus emoryi</i>	Emory Oak	40	50	3	15	11,697
<i>Quercus gambelii</i>	Gambel Oak	15	30	3	15	1,645
<i>Quercus ilex</i>	Holly Oak	50	50	3	15	18,276
<i>Quercus suber</i>	Cork Oak	40	60	2	10	7,798
<i>Quercus turbinella</i>	Shrub Live Oak	10	10	2	10	487
<i>Quercus virginiana</i>	Live Oak	50	50	3	15	18,276
<i>Rhus lancea</i>	African Sumac	40	30	2	10	7,798
<i>Rhus microphylla</i>	Littleleaf Sumac	10	10	2	10	487
<i>Rhus ovata</i>	Sugar Bush, Sugar Sumac	15	15	2	10	1,097
<i>Rhus virens</i>	Evergreen Sumac	12	12	2	10	702
<i>Rosa banksiae</i>	Lady Banks Rose, Tombstone Rose	20	20	3	15	2,924
<i>Rosmarinus officinalis</i>	Bush Rosemary	8	3	1	0	0
<i>Ruellia californica</i>	Ruellia	4	4	3	15	117
<i>Ruellia peninsularis</i>	Ruellia	4	4	3	15	117
<i>Ruschia uncinatus</i>	Ruschia	1.5	1.5	2	10	11
<i>Salvia chamaedryoides</i>	Blue Sage	2	2	2	10	19
<i>Salvia clevelandii</i>	Cleveland Sage	5	5	3	15	183
<i>Salvia columbariae</i>	Chia	1	1.5	3	15	7

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
Salvia farinacea	Mealy Blue Sage	1	1	3	15	7
Salvia greggii	Texas Red Salvia, Autumn Sage	3	3	2	10	44
Salvia mohavensis	Mohave Sage	3	3	2	10	44
Sambucus mexicana	Mexican Elderberry	20	30	2	10	1,949
Santolina chamaecyparissus	Lavendar Cotton	3	2	2	10	44
Santolina virens	Green Santolina	2	2	3	15	29
Sapindus saponaria saponaria	Soapberry	30	30	3	15	6,579
Sapindus saponaria drummondii	Soapberry	30	30	2	10	4,386
Schinus molle	California Pepper Tree	45	40	2	10	9,869
Senecio cineraria	Dusty Miller, Silver Plant	2	2	3	15	29
Senna covesii	Desert Senna	1	1	1	0	0
Senna lindheimeriana	Senna	2	3	4	20	39
Senna wislizenii	Cassia, Shrubby Senna	8	8	2	10	312
Sesuvium verrucosum	Sea Purslane, Ice Plant	3	0.5	2	10	44
Setaria macrostachya	Plains Bristle Grass	1	3	3	15	7
Simmondsia chinensis	Jojoba, Goat Nut	8	8	1	0	0
Sophora secundiflora	Texas Mountain Laurel	15	25	2	10	1,097
Sphaeralcea spp.	Globe-Mallow	3	3	1	0	0
Sporobolus airoides	Alkali Sacaton	3	5	3	15	66
Sporobolus contractus	Spike Dropseed	1	3	1	0	0
Sporobolus cryptandrus	Sand Dropseed	1	2	3	15	7
Sporobolus flexuosus	Mesa Dropseed	1	3	2	10	5
Sporobolus wrightii	Sacaton	4	5	1	0	0
Stenocereus (Lemaireocereus) thurberi	Organ Pipe Cactus	12	20	1	0	0

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Stipa neomexicana</i>	New Mexico Feathergrass	1	3	2	10	5
<i>Tagetes lemmoni</i>	Mountain Marigold	6	6	3	15	263
<i>Tamarix aphylla</i>	Athel Tree, Tamarisk	50	50	1	0	0
<i>Tecoma stans angustata</i>	Trumpet-Bush	8	10	2	10	312
<i>Tecomaria capensis</i>	Cape Honeysuckle	6	6	4	20	351
<i>Teucrium chamaedrys</i> (prostratum)	Prostrate Germander	2	1	2	10	19
<i>Teucrium fruticans</i>	Bush Germander	8	8	3	15	468
<i>Trichloris crinita</i>	Two-feather Trichloris	1	3	2	10	5
<i>Trichocereus</i> spp.	Trichocereus Cactus	3	5	1	0	0
<i>Tridens muticus</i>	Slim Tridens	0.5	1.5	2	10	1
<i>Ungradia speciosa</i>	Mexican Buckeye	12	12	3	15	1,053
<i>Vauquelinia californica</i>	Arizona Rosewood	15	25	2	10	1,097
<i>Verbena gooddingii</i>	Goodding Verbena	3	1.5	3	15	66
<i>Verbena peruviana</i>	Peruvian Verbena	3	0.2	4	20	88
<i>Verbena tenuisecta</i> (pulchella)	Moss Verbena, Fineleaf Verbena	5	1	3	15	183
<i>Verbesina encelioides</i>	Crown Beard	3	3	2	10	44
<i>Viguiera deltoidea</i>	Golden Eye	3	3	2	10	44
<i>Vitex agnus-castus</i>	Chaste Tree, Monk's Pepper	25	25	2	10	3,046
<i>Washingtonia filifera</i>	California Fan Palm	15	45	2	10	1,097
<i>Washingtonia robusta</i>	Mexican Fan Palm	10	75	2	10	487
<i>Xylosma congestum</i>	Xylosma	15	15	3	15	1,645
<i>Yucca aloifolia</i>	Spanish Bayonet Yucca	5	10	1	0	0
<i>Yucca baccata</i>	Banana Yucca	5	3	1	0	0
<i>Yucca brevifolia</i>	Joshua Tree	30	30	1	0	0
<i>Yucca carnerosana</i>	Giant Dagger Yucca	4	10	1	0	0
<i>Yucca elata</i>	Soaptree Yucca	8	20	1	0	0
<i>Yucca glauca</i>	Small Soapweed Yucca	3	3	1	0	0

Botanical Name	Common Name	Canopy Size	Mature Height	Water Use Type	Use"	Annual Use Gal.
<i>Yucca recurvifolia</i> (pendula)	Pendulous or Curveleaf Yucca	6	6	2	10	175
<i>Yucca rigida</i>	Blue Dagger Yucca	5	12	1	0	0
<i>Yucca rostrata</i>	Beaked Yucca	9	12	1	0	0
<i>Yucca schottii</i>	Mountain Yucca	4	15	1	0	0
<i>Yucca treculeana</i>	Tree Yucca	2		1	0	0
<i>Yucca whipplei</i>	Our Lord's Candle	6	3	1	0	0
<i>Zauschneria californica</i>	Hummingbird Trumpet	2	2	3	15	29
<i>Zexmenia hispida</i>	Rough Zexmenia	2	2	2	10	19
<i>Zinnia acerosa</i>	Desert Zinnia	1	1	1	0	0
<i>Zinnia grandiflora</i>	Rocky Mountain Zinnia	1	1	2	10	5
<i>Zizyphus jujuba</i>	Chinese Date, Common Jujube	30	40	2	10	4,386

TABLE – A

ADWR PLANT LIST WATER USE FACTORS AND AVERAGE EVAPOTRANSPIRATION RATES

PERCENT OF Eto	ANNUAL IRRIGATION REQUIREMENT AT MATURITY
0%	Plant Type 1 = 0 inches assumes plants will be weaned from irrigation once established
13%	Plant Type 2 = 10 inches
19%	Plant Type 3 = 15 inches
26%	Plant Type 4 = 20 inches
71%	Oasis Plants and Turf = 55 inches

The table is based on 1) the individual plant water use factors 1- 4 from the Arizona Department of Water Resources Low Water Use/Drought Tolerant Plant List, which correlate to percent of Eto required by the plant in Tucson, Arizona;